RADIO and ELECTRONICS

ELECTRICITY — COMMUNICATIONS — SERVICE — SOUND

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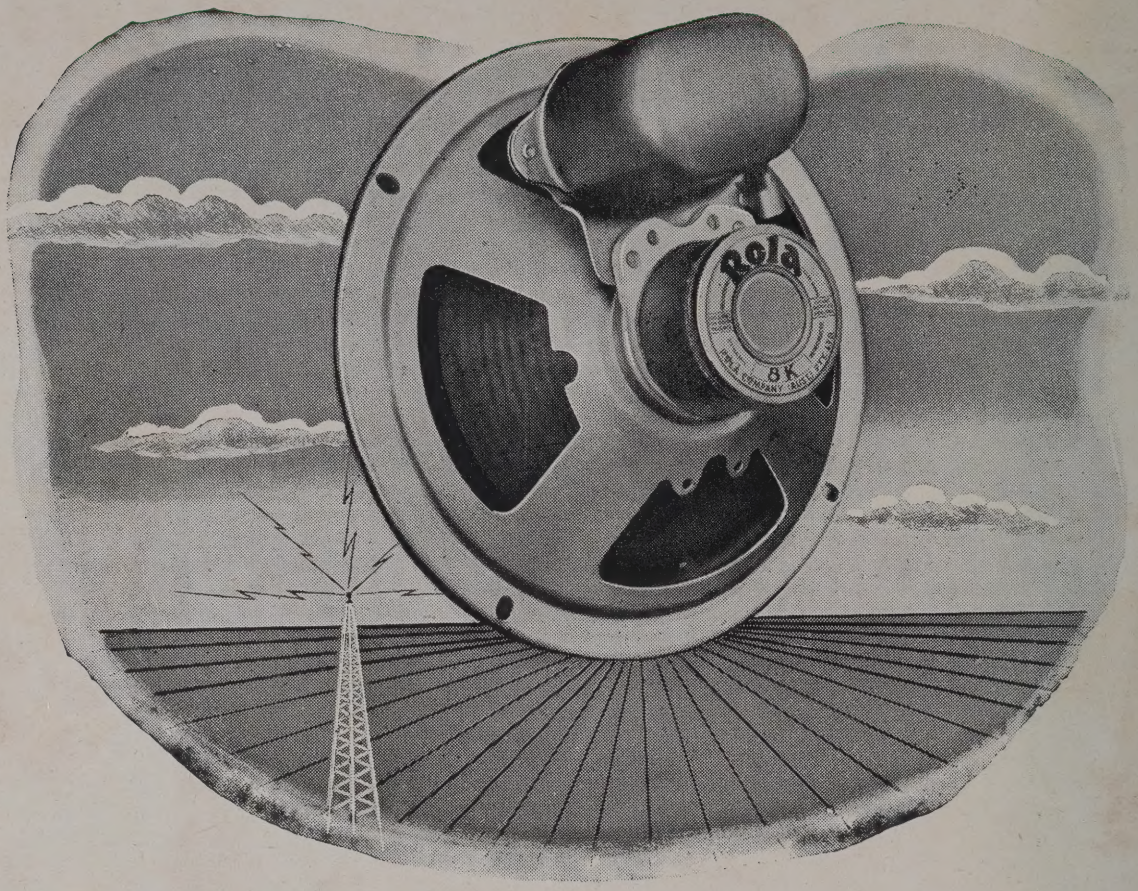

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Vol. 5, No. 3 May 1st, 1950

Editorial 1

A Sub-Miniature Receiver for Radio Control 4

Actuator Mechanisms for Radio Control 9

New Zealand Radio Traders' Federation Annual General Meeting 14

Tube Data:
Types 6AT6, 6AU6, and 6BA6 17

A Portable Transmitter for Radio Control Work 20

The Philips Experimenter:.....
No. 31: Some of the New Philips Range of Transmitting Valves 24

New Pocket Radio—Can Only be Heard by User 26

The *Radio and Electronics* Abstract Service 27

For the Serviceman:
Akrad Radio Corp. Receiver, Model 6P8 33
Akrad Radio Corp. Receiver, Model 5G9 34

The New Zealand Electronics Institute (Inc.) Newsletter 36

Our Gossip Column 38

Trade Winds 39

New Products:
Latest Releases in Electronic Equipment 44

Classified Advertisements 46

OUR COVER

This month's cover shows the sub-miniature three-valve radio control receiver designed and built in our laboratory. It is shown alongside a 1C5 valve to illustrate its minute size. A full technical description will be found on page 4 of this issue.

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CORRESPONDENCE

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GUY E. MILNE
ELECTRONIC TECHNICIAN

A Special Issue

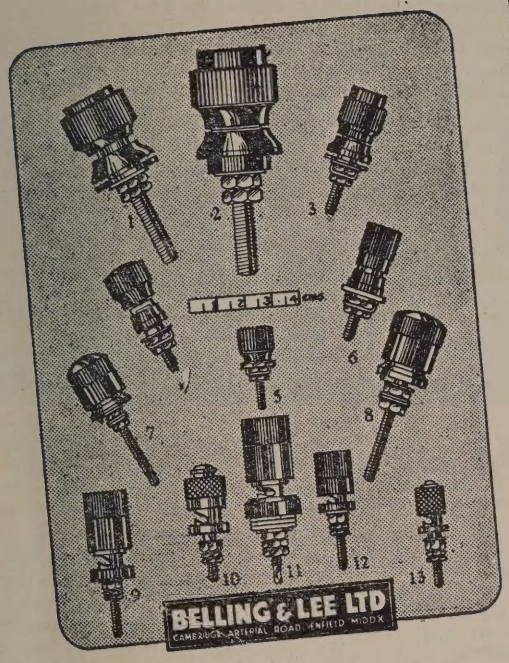
In this isssue we have departed from our normal practice to some extent in presenting a series of articles, all covering one particular aspect of a single subject—radio control. As we mentioned in this page last month, some work on the development of a radio control receiver has been brought to a successful conclusion; we have therefore taken this opportunity to place in a single issue enough practical material to enable anyone who may be interested to build and operate a successful control system.

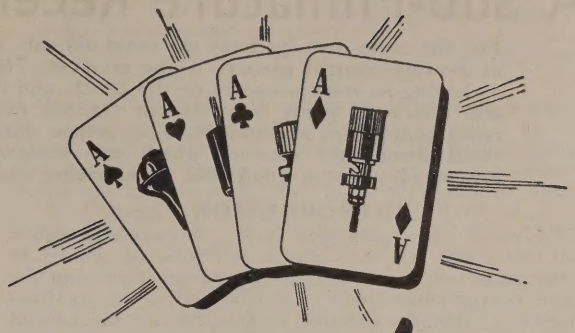
This has not been done solely because we think that large numbers of our readers are interested in the subject, but most of all because the subject is one which we think might appeal to very many people, given enough practical information to get them started. In other words, by illustrating the principles of radio control in a practical way, it is hoped that a good deal of dormant, or perhaps latent interest may be aroused. It is the function of a magazine such as this both to cater for known tastes on the part of readers, but it is equally important that it should break new ground, and particularly so where the novelty of the subject matter is such that interest may be aroused. No one ever became interested in a thing because he did *not* read about it.

A Word of Warning

At the same time as we are publicizing radio control, it is essential to point out that the transmission, even of minute amounts of power, is illegal except for persons duly licensed by the authorities to do so. Unfortunately, this prohibition applies to the transmissions necessary in remotely controlling any object by radio. In particular, the only people authorized to conduct radio control work are licensed amateur transmitters. While this does not prevent anyone from building a receiver, or even an oscillator, it does prevent them from using an oscillator, attached to an aerial for the purpose of radiating a signal. It might thus be argued that we are wasting our time in describing radio control equipment, but even with the regulations such as they are, we hardly think this to be so. Anyone who is not a licensed amateur, but who wishes to operate radio control equipment may do so as long as an amateur is present to supervise operations, and ensure that the transmission is within the allotted frequency band. Thus, the correct thing for anyone who has no transmitting license, is to contact an amateur transmitter, who has, and get him to sponsor the control work when it comes to actual transmission. There is nothing to prevent receivers being tested with the aid of a signal generator or small oscillator as long as no aerial is attached.

In Great Britain, frequencies are allotted for free use, without a transmitting license, by anyone at all, for the purpose of radio controlling models, and it is hoped that something of the same sort may be done here, as it would enable much freer use of radio control to take place. In the meantime, however, intending experimenters should be careful to work a transmitter only with the co-operation of an amateur, for should he do so on his own account, he will be "pirating," which is very sternly regarded by the authorities. Not only is a stiff fine likely in such cases, but any infringement of the regulations will hardly encourage the authorities to consider the allotting of frequencies for general use.





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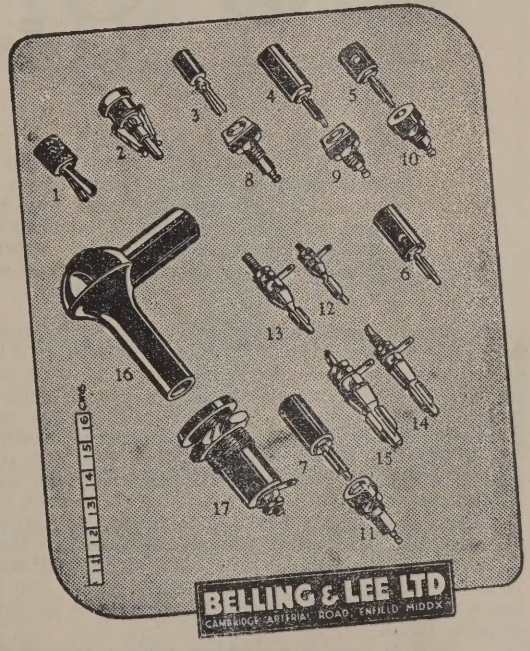
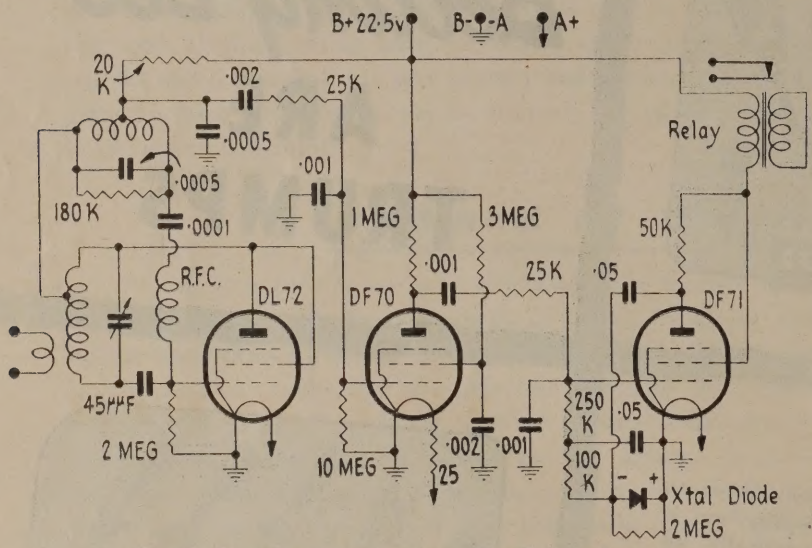


A Sub-Miniature Receiver For Radio Control

For the radio man, perhaps the most difficult, and at the same time, the most interesting part of a radio control system, is the receiver. This has to conform to many specifications, as well as having to work properly on the bench, and its construction is a matter which we feel sure will interest a great many of our readers, even if they have no immediate idea of trying out radio control for themselves. This article describes the design and construction of a very small three-valve receiver which was designed and built in our own laboratory, and which has stood up to a good deal of knocking about in the field without detriment to its efficiency.

INTRODUCTION

Radio control of models is a very fascinating subject, and one which may well give a new lease of activity to many amateurs and other builders whose interest in the more conventional kinds of radio activity has perhaps flagged a little. We mention models, because the control by radio of a working model of an aircraft or boat, or what-have-you is perhaps the most entertaining method of using remote control by radio. This does not mean that the control of models is all that can be done by means of radio remote control. Far from it. Once a receiver has been built that can close a relay at the behest of a transmitted signal, there is literally no limit to what can be controlled. Any operation at all that can be done by a switch can be remotely controlled without the use of connecting wires between the mechanism controlled and the position of the person in control. For this reason, anyone who has a remote control problem which for any reason cannot be done by a wired control system, can, if he chooses, solve the problem by means of radio, and although the series of articles in this issue are directed more specifically towards those with an interest not only in radio, but also in models, it does not follow that someone who is not at all interested in them will not find the articles useful.



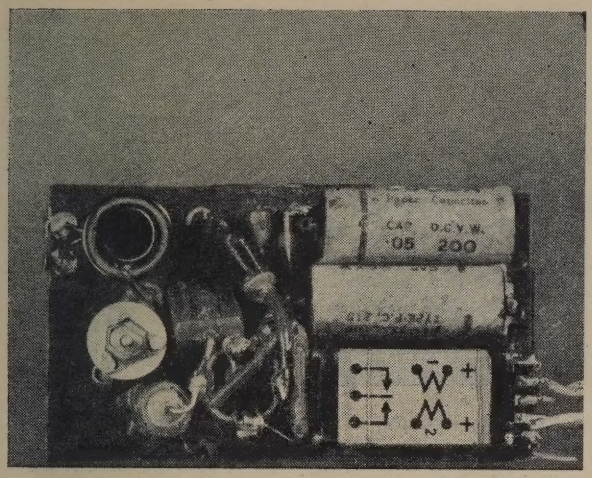
Circuit diagram of the receiver. The R.F. coil consists of 9 turns of 20 gauge wire double-spaced on a ½ in. diameter former. The quench oscillation coil (the upper left-hand one) is described in the text. Note: The relay valve is wrongly labelled in the diagram. Its type number should read DL71.

IDEAS BEHIND THIS NEW DESIGN

As we mentioned in last month's editorial, the receiver about to be described can be regarded as mildly revolutionary in its class. The main reason for this is that it has been built round an extremely sensitive lightweight relay that has recently become available, and which has actually been advertised in these pages. This relay is robust, in spite of its sensitivity, and although it can be made to operate on as little as 75 microamps, it will not give trouble through vibration or knocking about, which is much more than can be said for less pretentious relays, with nowhere near the same sensitivity.

When it was found that these relays were available, and should be satisfactory from the point of view of mechanical stability, for use in a radio control receiver, there opened up rather a wide field of speculation as to just how small and light a receiver could be made, if designed to work this particular relay. Ordinary miniature valves, it seemed, would not be very satisfactory, not because it would be difficult to get enough current to operate the relay, but rather for the somewhat novel reason that it would be hard to get enough control voltage to bring one of these valves sufficiently close to cut-off to de-energize the relay! An examination of the curves of a large number of battery-operated miniature valves showed that none of them would be really suitable. The sub-miniature hearing-aid tubes, however, looked very promising, in that they are normally made to work as audio amplifiers with only 22.5 volts of H.T. This seemed the most attractive thought to date, because the basic problem we had set ourselves was not simply to build a receiver that would work, but to build one lighter, and perhaps smaller, than had been done before, without at the same time sacrificing anything in the way of sensitivity or reliability. In attempting to do this, one of the chief snags appeared to be that of battery weight.

It had been pointed out to us that the chief difficulty about reducing size and weight in radio control receivers is the fact that the smallest dry B battery available, the 45 volt Minimax, has a far greater capacity in milliampere hours than can ever be made use of in this class of service. In other words, using these batteries, one is carrying round with the receiver a weight of B batteries that is out of all proportion to the set's requirements. If, then, any scheme can be devised which will reduce the weight of the batteries, then this should be the best way of reducing the total weight. Now the idea of making the receiver work from a B battery of only 22½ volts can be seen to be particularly attractive, since if it can be done, we can lose half the weight of the smallest



Top view of the receiver. This should be compared with the wiring diagram on Page 7. Most of the resistors are obscured by the two large condensers in the upper right-hand corner.

existing B battery at one fell swoop, as it were.

Accordingly, some sub-miniature tubes, such as are used in hearing aids were procured, and some experiments were conducted to find out whether one of them could be used successfully as a super-regenerative detector at 52–54 mc/sec.—the amateur band allotted for radio control work. Somewhat to our surprise, we must admit, it was found that not only could a super-regenerative detector be made to work at these frequencies with the DL72—one of the sub-miniature power amplifiers—but that it would work well with only 22½ volts, as we had hoped! We were now "getting hot," as the children's game has it, and were certain that we were on to something good. Incidentally, the sensitivity of the experimental detector circuit appeared to be all that could be desired, so that the only thing to cause real concern was the fact that the super-regenerative hiss was very slight, even when the receiver was working perfectly as a super-regen. detector. Was the receiver noise so small in amplitude that too much audio amplification would be needed to make the receiver a practical one for radio control? That was now the burning question, and no time was lost in setting up a circuit to see. After a certain amount of difficulty, which we need not go into here, but which was finally overcome, it was found that the basic system of Mr. L. H. Wright, whose articles readers will remember, was quite workable, and a three-valve circuit was finally developed that looked as if it would without doubt do the job required of it.

PERFORMANCE OF THE SET

To show at the outset what had been achieved at this stage, here is a list of the operating requirements and characteristics of the set whose circuit had been made to work on the test bench.

1. Valve Line-up

Super-regenerative detector	DL72
Audio voltage amplifier	DF70
Audio amplifier and relay valve	DL71

2. Operating Voltages and Currents

Total A battery current	75 ma.
A battery voltage	1.5 v.
Total B battery current (relay open)	300 μamps. (approx.)
Total B battery current (relay closed)	500 μamps. (approx.)
B battery voltage	22½v.

When this is compared with previous receivers working on the same principle, and using a relay with a closing current of 5 ma. or so, it can be seen that the sub-miniature valves and the sensitive relay have a considerable advantage. For example, the circuit previously presented in Mr. Wright's article had an A battery drain of 250 ma. and a relay-on B battery drain of 8 ma. at 45 volts!

Thus, apart from reducing the B battery weight by a half, there now enters the possibility of using a real hearing-aid battery of 22½ volts, and weighing one ounce, instead of 45 volts taken from a 67½ volt Minimax, with a total weight of 8 ounces. Also, a small torch cell (one half of a No. 712 3-volt torch battery) weighing one ounce also, will have plenty of capacity for running the filaments of the new receiver, so that when and if the hearing-aid B batteries can be purchased, it will be possible to have a receiver working from A and B batteries weighing only 2 ounces in all. At the worst, a saving of four ounces in B battery weight is made even if the ordinary Minimax 22½-volt section is used for the B battery! The new circuit now appeared to have not just something, but everything!

THE FINISHED JOB

So far, of course, all we had was a circuit that worked, and which needed a phenomenally small weight of batteries. In practice, we were still a long way from realization of the ultimate object, as a glance at the circuit will show. For it contains quite a large number of parts, so far spread over a wide expanse of bench space, and it re-

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mained to be seen whether the whole thing could be made small enough in size and weight to match the minute battery requirements. The relay weighs only 1¼ ounces, and measures 1½ in. x ⅝ in. x ½ in., and is the largest and heaviest single component, so that the problem did not appear too difficult. After much poring over parts, and running round finding miniature paper condensers of low voltage rating, not to mention cogitation as to the best method of construction, it was decided that the best way to build the finished article was to mount everything on a small sheet of bakelized fibre board, which is light, strong, and a good insulator. Some novel methods of mounting small parts would be needed, and the valves would have to be hung on to the rest of the circuit by their wire connections, since no bases were available for them, but nothing daunted, our laboratory assistant took his courage and a six-inch rule in both hands, and set to work manfully. The result of his labours is now pictured for all to see. The set worked into a piece of fibre board measuring 3 in. x 1¾ in., and the total depth is 1½ in., making a total volume of 7.9 cubic inches. The cover picture shows the receiver, full size, alongside an ordinary 1C5-GT, two of which would take up more cubic space than the whole set! As the photographs show, there is not much spare room, and the circuit is definitely "layer-built," but there are no difficulties that the average radio amateur cannot tackle in duplicating it. We have departed from our usual practice in this instance and produced a wiring diagram, showing just where everything is on the "chassis," and this, together with the circuit, and table of connections between the tie-points, should enable readers who wish to do so to make an exact duplicate for themselves.

PRINCIPLE OF THE RECEIVER

For those who may not have seen Mr. Wright's previous article describing the principle of his control receivers, it will be as well if we commence with a brief description of the way in which the set works, without at first going into the finer circuit details. The first valve, the DL72, is the super-regenerative detector. This kind of receiver has one characteristic that makes it ideal for using as the basis of a control receiver. It is that in the absence of a signal, the set is not quiet, but gives a relatively large output in the form of random noise. This noise is really nothing but amplified thermal agitation noise, which is audible owing to the tremendous amplification of the super-regenerative detector. However, when a signal is received, this noise disappears completely. To make things better still, there is with the super-regenerative detector a very strong A.V.C. effect, in that signals below a certain very small strength fail to be received, but after a very well marked threshold is passed, any signal, of whatever strength, squashes the super-regenerative hiss altogether. We thus have the characteristic that the operation of the set is always exactly the same, out to a very sharply defined maximum range, where reception ceases abruptly. In other words, owing to the A.V.C. action inherent in the circuit, there is no noticeable falling off in performance until maximum range is reached.

Thus, the principle of the receiver is this—to amplify the noise produced by the detector, rectify it, and use the resulting D.C. voltage as a negative bias, to hold off the current in a valve, the relay tube, in whose circuit is the operating coil of the relay. Then, when a signal is received, the noise disappears, the D.C. bias on the relay tube disappears too, and the tube draws enough current to operate the relay, which closes and works the actuating mechanism, turning the rudder. When the transmitter key is lifted, the signal disappears, and the noise starts once more and biases the relay tube back, allowing the relay to open again. All this sounds very simple, and it is, too, but in practice making the set work on this principle has a few difficulties that have to be overcome by proper circuit design.

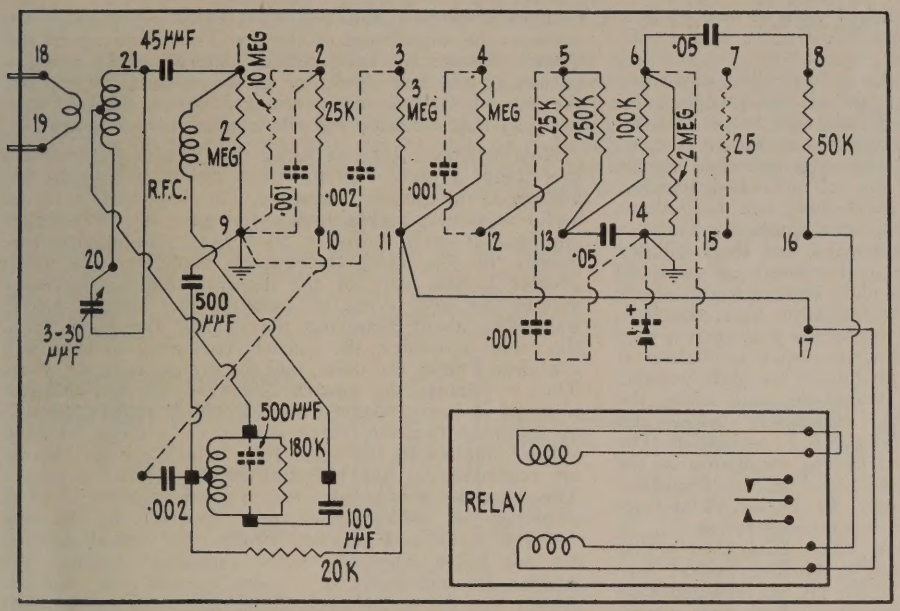
Underneath view of the set. This also should be compared with the wiring diagram. The valves can be seen here. They are supported solely by their flexible leads, which are soldered to the lugs inserted in the fibre "chassis" as described in the text.

Chief among these is the difficulty of filtering out the quench voltage from the output of the detector without removing the noise too. This is a very important function of the circuits following the detector, and since a thorough understanding of the working of the set is necessary for anyone who is to build and adjust one, we will digress a little at this point, and have something to say about the way in which a super-regenerative detector works.

HOW THE SUPER-REGENERATIVE DETECTOR ACTS

The super-regenerative detector was invented and used for a long time without anyone, even Armstrong, the inventor, having any very clear idea of how it worked. Since then, however, a considerable amount of research has been done on the matter, and we now have a very presentable idea of what goes on inside a super-regenerative circuit. In particular, when Ross A. Hull first invented the principle on which our present set works—namely distinguishing between the noise and the lack of it in a super-regenerative set, he had to proceed by a system of trial and error in developing a circuit that worked, and the literature of the day makes it quite clear that Hull did not know *why* it worked, even after he had been successful. We will refer again to this point later, for in the light of present knowledge it is very easy to see why.

Briefly, the super-regenerative detector is a regenerative detector with a difference. You will remember how the ordinary regenerative detector gets its tremendous sensitivity—by being adjusted to the point where it is just not oscillating. At this point, the losses in the tuned circuit are almost exactly balanced by the energy fed back from the plate circuit, so that the amplification of the coil is made much higher than usual. In the super-regenerative detector, the valve is connected in an oscillator circuit also, but here we do not have a control, to set the circuit at its most sensitive spot. Instead, there is some means of modulating the detector—usually by



Lug. No. 1, Grid DL72
2, Grid DF70
3, Screen DF70
4, Plate DF70
5, Grid DL71
7, Fil. +, DL71 and DL72
8, Plate DL71
9, Fil. —, DL72.
11, B+
14, Fil. —, DL71 and DF70
15, Fil. +, DF70
16, Relay
17, B+
18 and 19, Aerial
20, Centre of Philips trimmer, and plate DL72
21, Outside lug of Philips trimmer.

Note: Battery leads are taken from lugs 7, 9, and 11.

Wiring diagram showing the placement of parts and the relative positions of the solder lugs that are riveted to the fibre chassis. Only the valves are not shown, but their connections to the circuit are given in the table above. The parts and wiring that are dotted are below the chassis, and those that are drawn solid are above it.

plate modulation—so that at a very rapid rate, the plate voltage is taken from a value rather lower than the D.C. value to another value somewhat higher than the D.C. plate voltage. Now it is well known that as the voltage on an oscillator is reduced, a point is reached where it ceases to function, and will not start again until the plate voltage has been raised. When this is done, the voltage at which oscillation starts is sometimes called the "striking voltage." Now the point about the modulation of the detector plate voltage is that for super-regeneration to take place, the oscillator must stop for a time during the negative half-cycle of the modulation voltage. In other words, the modulating voltage must be able to reduce the plate voltage below the striking voltage of the oscillator circuit. The striking voltage depends not only on the valve, but also on the circuit, the losses in the parts that make it up, and the filament voltage.

This business of modulation is most important to understand, because it is a necessary piece of knowledge when it comes to adjusting the circuit, once it has been put together. However, the foregoing paragraph is all that it is necessary to know, basically. The other important thing is the way in which this modulation is brought about. One way of doing it would be to have a low-frequency oscillator, and to use it to plate-modulate the R.F. oscillator. This kind of circuit has often been used, and is known as the *separately-quenched* super-regenerative. In other words, a separate oscillator is used to supply the quench voltage, which is simply another name for the modulating voltage that we have been discussing. In making a super-regen. work, there are a number of things about the quench voltage that can affect the result. First, its amplitude, secondly its frequency, and thirdly, its wave-form. We do not intend to go into more detail than necessary here, so we will simply give some of the facts, without troubling about their reasons. For instance, it has been found that for a frequency of 50 mc/sec, or so, the best modulating frequency, or quench frequency, as we will henceforward call it, is about 20 kc/sec.; it can be higher without affecting the performance very much, as long as it does not get too high. About 100 kc/sec. is the practical limit. All these frequencies are outside the audio range, and so the fact that the detector is being modulated cannot be heard, as it would be if the modulating frequency were lower—say 5,000 c/sec. The quench voltage therefore causes no disturbance in the speaker or 'phones, if these are used. That is not to say, however, that an audio amplifier will not amplify it, because most of them have some amplification left, even as high as 20 to 100 kc/sec.

The separately quenched super-regenerative is perhaps one of the easiest types to get going, because the amplitude and frequency of the oscillation, and so the degree of modulation of the R.F. oscillator can be controlled easily. However, it would not be very suitable for the purpose of this set, because of the extra valve that would be required, and the extra battery drain. The second type of super-regenerative detector is called "self-quenched." All single-valve types with only the R.F. coil in the circuit are of this type. Here, the modulation is obtained in a different way. The R.F. oscillator is made to oscillate so hard that each time it starts, so much grid current flows through a high value grid leak that it shortly becomes cut off, owing to the charging negatively of the grid condenser. Then, of course, it stops oscillating, and cannot start until the grid condenser has discharged itself. When the circuit conditions are correct, this blocking action, known usually as "squegging," takes place at a rate of 20 to 100 kc/sec., so that the squegging action does the same thing as the separate quench oscillator, allowing the R.F. oscillation to take place for only a few cycles, before stopping it again. Unfortunately, the self-quenching super-regenerative has several disadvantages, especially for radio control work, although it can be made to work quite well. One advantage of the separately quenched detector is that it produces much

more noise than the self-quenched variety, and so in a control set, much less audio amplification is needed with the separately quenched circuit.

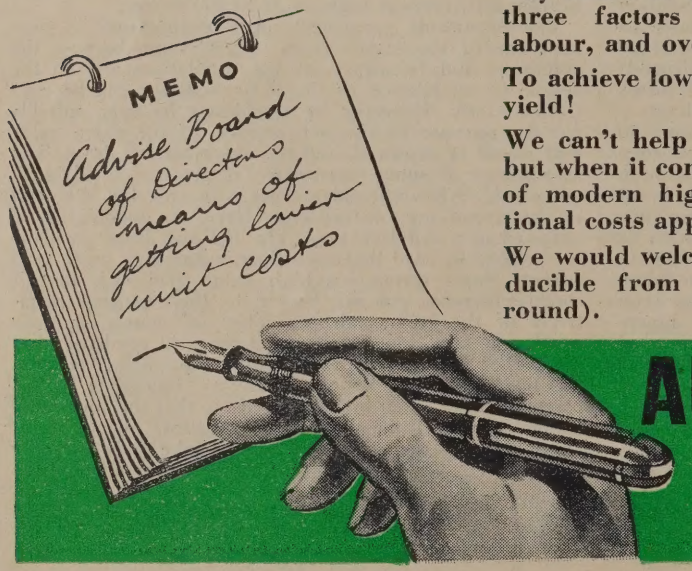
The detector circuit used here is neither separately quenched, nor the squegging type of self-quenched detector. It is actually a sort of half-way house between the two, as a glance at the circuit will show. It combines the advantages of the separately quenched circuit with the one-valve circuit of the self-quenched detector. Here, we have a single valve performing two oscillations, at widely differing frequencies, simultaneously. There is a tuned circuit for both frequencies, and the oscillator does not squegg. It oscillates continuously at about 50 kc/sec., and in the process its plate voltage varies above and below the D.C. value. At the same time, the R.F. oscillation circuit is attached to the valve in such a way that it has no effect on the low-frequency oscillation at all. But the latter oscillation modulates the plate voltage, just as a separate oscillator would do, and causes the detector plate voltage to go alternately below and above the "striking voltage" for the R.F. oscillation. The detector therefore goes in and out of oscillation at the radio frequency, at a rate determined by the frequency of the L.F. oscillation, namely 50 kc/sec. Thus, we again have the conditions for super-regeneration.

What it is necessary to know, apart from this, is that the mere fact that the oscillator is working at both frequencies at once does not make it super-regenerate. For if it is oscillating *continuously* at both frequencies, it will not be acting as a super-regenerative detector. No more will it if it is oscillating only at R.F. or only at the quench frequency. The trick of making the set work properly, therefore, is to get the *amplitude* of the quench oscillation correct, and this will be discussed when we come to the adjustment of the set. The frequency of the quench voltage we have already determined by using a particular coil and condenser in the quench circuit, and the wave-form has only a minor effect on the performance, so that we have the whole thing under control.

Now whatever type of super-regenerative detector we use, there is present in the plate circuit a considerable voltage at the quench frequency. This is passed on to the audio amplifier, and although the gain of the average amplifier is well down at 50 kc/sec., the quench frequency in this case, the quench voltage is so much greater in the plate of the detector than is the noise voltage we are trying to amplify, that unless we do something about removing the quench frequency from the audio amplifier, the quench frequency voltage will completely mask the noise, and the system will not work. This is because the quench voltage is present whether a signal is being received or not, and if it gets through to the bias rectifier, there is always a large rectified voltage applied to the relay tube, which remains biased off regardless of the presence or absence of a signal. This was the reason why the original receiver of Hull employed an audio transformer between the detector and the audio and rectifier system. He stated that he did not know why, but with resistance coupling, the scheme did not work. It is clear enough now that the reason was the quench voltage, which could get through a resistance-coupled amplifier, but which was automatically filtered out by a transformer, which would not pass the quench frequency.

(Continued on Page 41.)

This Question of Costs



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ACTUATOR MECHANISMS FOR RADIO CONTROL

Although the subject of actuator mechanisms is not strictly a radio topic, it is so closely allied to remote control by radio that the present issue would hardly live up to its name as a Special Edition without some mention of the gear which actually does the work after the receiver and transmitter have performed their control function. This article therefore illustrates a number of mechanisms that can be used in controlling models. Most of the illustrations refer to model aircraft, but this does not prevent them from showing what should be done in controlling, say, a model boat.

INTRODUCTION

Since we have in this issue embarked on the subject of remote control, and since most of those interested will be wanting to apply the control to models, it is essential to give readers, who may not be familiar with the current model literature, some idea of the types of mechanism that can be used, following the control receiver, to actually do the work required. In the case of models, the most likely work will be that of turning a rudder, and so controlling the direction of the model, whether it be an aircraft, a speedboat, or a yacht. The possession of a receiver which closes a relay on receipt of a transmitter signal is really only the first step in controlling anything. Once we have it, however, it is possible to control anything, from models to full-sized machines of any sort, but there must be some intermediate mechanism, either electrical or mechanical, which is large and robust enough to perform actual physical work. By this we mean that to move the control surface of a model, force is necessary, even if only a small one, and the receiver itself is incapable of exerting any force except the extremely minute one needed to work the sensitive relay.

The above, then, is the purpose of the actuator mechanism. If the remote control is for performing a simple operation like turning on an electric motor, or switching on some other electrical device, the "actuator" needs only to take the form of a second relay, which is robust enough to pass through its contacts the current the motor or other machine passes. In the case of directional control of models, the actuator needs to be a little more complex than just a second relay. This is because the final requirement is mechanical movement, and also because for a rudder, we want to have three controlled positions at least, namely left, right, and centre.

In a previous article by L. H. Wright, a description was given of two basic actuator mechanisms. In one, a small rubber motor is constrained by an escapement, similar to that used in a clock, in such a way that it can move only a quarter of a turn at a time. That is to say, when the transmitter key is pressed, the receiver relay operates an electro-magnet which allows the rubber motor to turn through only 90 degrees, after which it is held in position by a stop as long as the key is kept pressed. Then when the transmitter key is released, the electro-magnet is de-energized, and a spring pulls the stop out of the way of the catch on the rubber motor, which is allowed to revolve another quarter turn, when the catch comes up against another stop. Thus, every time the key is released, it moves a further quarter turn. Or, in other words, every time the transmitter key is *pressed and released* the motor moves one half turn. Now if the motor has a crank on the end of its shaft, this crank can be linked in one of a number of ways to the rudder of the model. Suppose, for the sake of argument, that the two positions of the crank arm that it can have when the key has been released are arranged to be at right-angles to the fore and aft centre-line of the model. If this is so, then *both* these positions of the crank will represent the neutral, or central position of the rudder. Then, when the crank is in one of the other two positions, the linkage will *pull* it to one side of the central position, and when it is in the opposite position, the rudder will be *pushed* to the other side of neutral. Then, as the crank goes round and round in response to repeated signals, it will move the rudder to *left* when the key is pressed, to *centre* when it is released, to *right* when the key is pressed again, and to *centre* on releasing once more. We are thus enabled to have the rudder in either of the three positions, at will, with only one proviso,

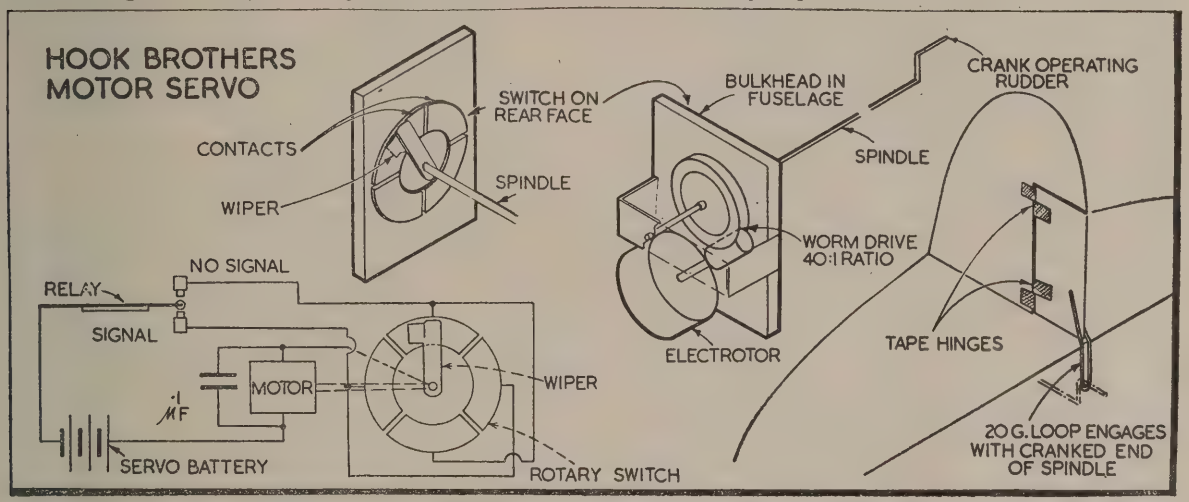


FIG. 8.—An actuating system developed by the Hook brothers in England. The similarity will be noted to the system of Mr. Wright, which is almost identical, and works in exactly the same way.

namely that if the turn was *right* the next one must be *left*, and vice versa.

This description has purposely been made as general as possible, without reference to any particular mechanism for the escapement or the linkage to the rudder. The main facts to grasp at the moment are (1) that the escapement has four positions, and goes through two of them every time the transmitter key is operated and released, and (2) that the four positions of the escapement wheel represent *right* and *left* separated by two neutral positions. In other words, as well as providing mechanical movement in response to the received signal, the escapement has also given us a *sequence* of operations, which must happen in turn, whether we like it or not.

NECESSITY FOR A SEQUENCE

At this point it would not be unnatural to ask "Why the sequence?" Surely we would be far better off with an arrangement that enables us to select right, left, or neutral at will, without being forced to go through two unwanted movements in order to arrive at the one we do want? Agreed, but to make a system that will do this for us is not so easy. For example, it *could* be done by having two receivers and two transmitters, tuned to different radio frequencies. We would then have a rudder held in neutral by a spring until one of the receivers worked, upon which a solenoid or electro-magnet would pull the rudder either left or right against the spring until the signal stopped. But to do so we have had to instal another receiver, and have one each for making the model turn left or right. Another way would be to have two actuators, one for each direction, controlled by two different modulation frequencies, in such a way that one tone would give left rudder, and the other, right, together with some means of automatically ensuring that after a signal of any sort, the rudder returned automatically to the neutral position. In either of these cases we have had to use *two communication channels*. The fact that in the second system, the two channels were different audio frequencies does not matter. They were two different frequencies, and therefore two channels. The audio tone system of control has, in fact, been made to work, and in cases where size and weight of gear is no objection, as in large model boats, it enables a large number of different operations to be performed, and without the bother of a sequence. However, for reasons which we cannot go into here, the multi-tone system is not really suitable for the majority of control purposes, mostly because of the difficulty of securing reliability together with simplicity and lightness.

The object of the two illustrations of how the sequence could be avoided was really to show why it is advisable to put up with the sequence in any case. Briefly, it enables us to avoid the use of two channels. If at radio frequencies, these would entail duplication of the receiver and actuating gear, and if at audio frequencies, many difficulties occur which render the scheme unworkable except in special cases, where weight and size do not matter.

NOT SO BAD AFTER ALL

Once we have got used to the idea that a sequence of events is a necessary evil, it is found that the disadvantages are not as great as might be suspected. Firstly, each action takes only a very short time, so that if it is desired to repeat a manoeuvre which has only just been made, the unwanted movement can be "wasted" by passing through it so quickly that the model has not time to answer the momentarily applied control. For example, if we have just turned to the left, and have returned the rudder the neutral by lifting the transmitter key, the next movement in the sequence (and it cannot be avoided) is *right* rudder. But if the key is pressed and released, very quickly, what happens is that the *rudder* actually does move to the right, and returns to neutral again in so short a time that the movement is ineffective as far as changing the course of the model is concerned. Now we are in a position to press and hold left rudder.

This takes quite a time to describe, but in practice, the only disadvantage of the sequence is that one must remember what the next rudder movement will be. Then,

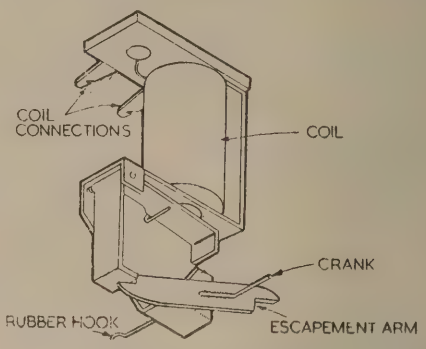


FIG. 1.—Drawing of a typical self-homing escapement mechanism.

if the next rudder movement is the one that is wanted by the controller, one pressure of the key will get it. If the next one is the opposite of what is desired, then a "press-release-press" will give the movement that is wanted.

The foregoing remarks apply to all systems where a sequence is used, and to all those described here.

SOME MECHANISMS ILLUSTRATED

One of the simplest actuating mechanisms is the self-returning escapement, driven by a rubber motor. For those who may not know the latter, it is simply a small skein of rubber, wound up after the manner of the rubber driven model aircraft. The one used here, of course, is very much smaller than any motor that may be used to drive a small model.

The escapement is shown in Fig. 1. It consists of a small electro-magnet. Mounted at one end is an arm of thin brass, bent at right-angles, and pivoted at one corner. One arm has a little piece of soft iron soldered to it, and is placed in such a position that the iron is close to the pole of the magnet (underneath in the illustration). A small spring is used to hold the armature slightly away from the pole of the magnet, much as in the armature of a relay. Mounted below the right-angled armature is a small piece of brass carried on a shaft of thin steel wire. The shaft is so placed that the ends of the arm are stopped by one or other of the ends of the right-angled armature. If the coil has current passing through it, as in the drawing, the lower, vertical piece of the armature stops the escapement arm from revolving under the influence of the rubber skein which is attached to the shaft of the escapement arm at one end, and is wound so as to turn the arm in a clockwise direction. When the current through the magnet coil is stopped, the armature springs away from the pole piece, taking the stop away from the escapement arm that is bearing on it. The escapement then rotates, because of the pull of the rubber, until a quarter of a turn later, it hits the stop on the horizontal half of the armature. When the transmitter is operated again, the stop moves away, as before, and the other end of the escapement

arm comes round and hits the stop, so that the whole thing can be seen to fulfil the requirement of turning a shaft (that of the escapement arm) through 90 degrees each time the key is pressed, and allowing it to automaticaly revolve another 90 degrees when it is released.

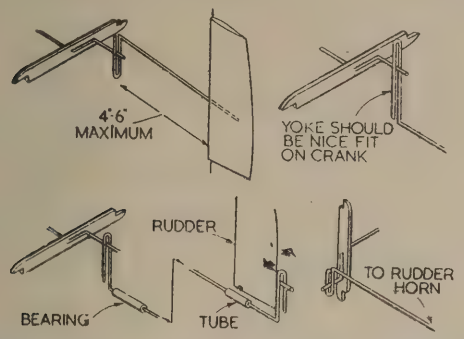


FIG. 2.—Some methods by means of which the crank movement of the escapement can be transformed into rudder movement.

The operating crank is made as part of the escapement arm's shaft, and to complete the control job, has to be linked in some way to the rudder of the model. Fig. 2 shows two ways in which this can be done. In the upper diagram, the crank is inserted in a yoke, which goes off to the rudder. The sideways movement of the crank turns the rudder to the left in the position drawn, and to the right in the opposite position of the crank. In the two positions where the crank is vertical, the rudder will clearly be central. The yoke transfers the horizontal movement of the crank,, but not its vertical movement. The lower diagram is an extension of the same method, in which it is desired to have the mechanism at a greater distance from the rudder itself. A long wire is then supported in bearings, and the wire is provided with a yoke at each end. One works from the crank of the escapement, while the other moves the rudder via a pin in its trailing edge.

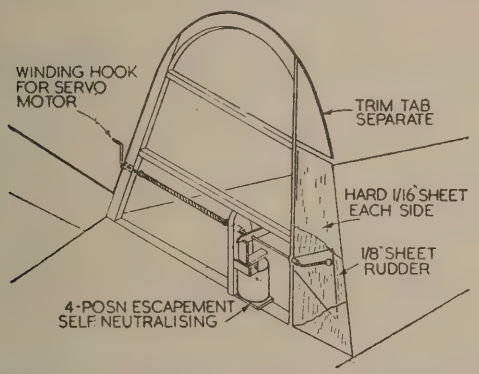

WINDING HOOK FOR SERVO MOTOR
TRIM TAB SEPARATE
HARD 1/16" SHEET EACH SIDE
1/8" SHEET RUDDER
4-POSN ESCAPEMENT SELF NEUTRALISING

FIG. 3.—An ingenious method of mounting the escapement, complete with rubber motor, inside the fin of a model aircraft.

A third method illustrated in the lower right portion of Fig. 2 is perhaps the simplest of all. The escapement is mounted with its shaft athwart-ships, and a push-rod is taken from the crank, straight to a lever, or "horn" mounted at right-angles to the rudder and about half an inch or so from the hinge line. The push rod can be made of light balsa in the case of an aeroplane, and the fittings at either end of it, of light wire. Fig. 3 shows an ingenious method of mounting the escapement, rubber motor, and all actually in the tail structure of a model aeroplane.

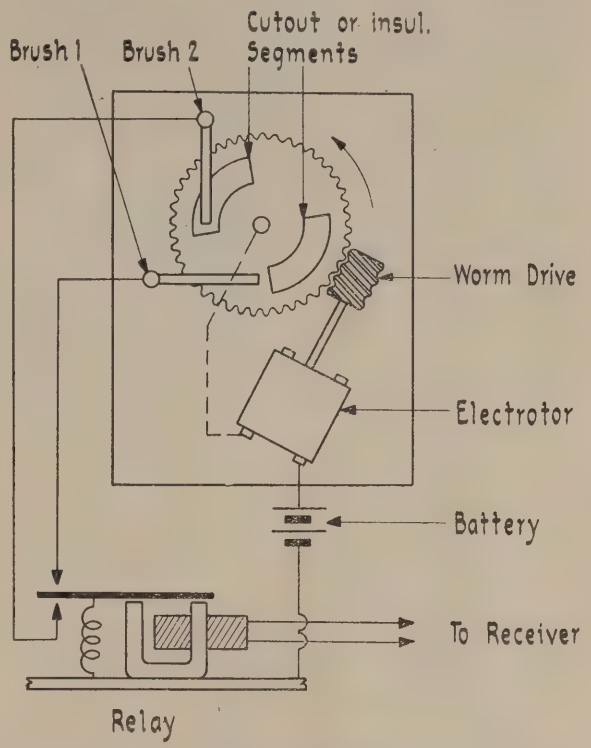


FIG. 4.—Mr. Wright's motor-driven actuator. Not shown is the crank, which is on the underside of the gear wheel.

MOTOR-DRIVEN ESCAPEMENTS

In the second article in this journal by Mr. Wright, he described an actuator driven by an electric motor instead of an escapement. This scheme has a distinct advantage over the rubber-driven escapement in its superior reliability, but loses out slightly on the score of weight. However, except where radio is to be installed in a very small and light model, the extra ounce or so that the motor-driven actuator might weigh compared with the rubber-driven one is hardly worth considering, for in this sort of gear, reliability is a pearl of great price, and not to be sacrified lightly, even for a little weight, since there are so many things that the operator has to watch if he is to be successful. A properly constructed motor-driven escapement can be installed and forgotten, since it will keep on working as long as the batteries hold up. The rubber motor, on the other hand, has several minor disadvantages that make it less desirable, especially as very small and light electric motors can be purchased quite readily. However, the rubber escapement can be made quite reliable, with care, and as can be seen from the diagrams, needs only the most primitive tools to construct, whereas better facilities are needed for making a motor-driven unit.

Fig. 4 is a schematic diagram of Mr. Wright's motor-driven actuator. We have called it an escapement, because

it does exactly what the rubber-driven type does. The only difference is that the rotation is limited to the quarter turn not mechanically, but by electrical means. This system comprises three parts. The motor, a relay to turn it on, and a reduction drive complete with a simple brush system. The latter has the purpose of ensuring that every time the motor starts, the final wheel (not the motor shaft) does only one-quarter of a revolution. The brush system therefore corresponds to the escapement arm and the movable stops of the previous mechanism. The relay can be the one that is directly operated by the receiver as long as it has the necessary change-over contacts. Should the relay have only a make-and-break contact, it will be necessary to use a secondary relay, worked from the receiver relay. In the diagram it can be seen that the motor derives its current in the following way. One terminal is permanently connected to the positive pole of the battery. The negative battery pole is connected to the frame of the relay, and thus to the moving armature. The two contacts are wired each to one of the escapement brushes, as we will call them, and the other terminal of the motor is connected to the contact wheel. Thus, unless the escapement brush which is connected to the relay armature at any particular time is bearing on the wheel, the motor will be stopped. The normal position of the relay is when it is de-

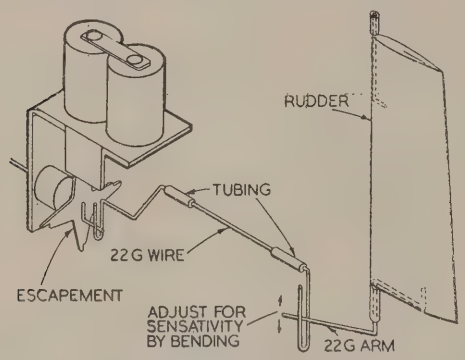


FIG. 5.—An escapement of the second type. It is not self-homing, a separate signal being needed to return the rudder to neutral.

energized, since current passes through its coil only when the transmitter key is pressed. The lower relay contact in the diagram is therefore made at all times, except when the key is pressed, when the armature moves over, makes the upper contact, and breaks the lower one. On releasing the key, the original state of affairs is restored.

We can therefore call the lower contact the "homing contact," and the upper one the "operate contact." In the diagram, the motor is stopped, since the brush (Brush 2) which is connected to the homing contact has run off the conducting part of the wheel, so that the motor circuit is broken. The drawing is not quite correct, in that it should show the relay armature in the "home" position, not between the two contacts, as drawn. The other brush, No. 1, is now contacting the wheel, and so is in a position to make the motor circuit, but for the fact that the relay is in the de-energized state, with the relay breaking the circuit to brush 1. Now, if a signal is sent to the receiver, the relay operates, and the "operate" contact is made, completing the circuit to the motor through brush No. 1. The motor therefore runs until brush No. 1 passes off the conducting segment, when the motor stops. Since the segment is 90° of the wheel, the latter goes through 90° before stopping. Now, when the No. 1 brush leaves the conducting segment, No. 2 brush makes contact with it. This does not prevent the motor from stopping, because the key is still down, and the relay is

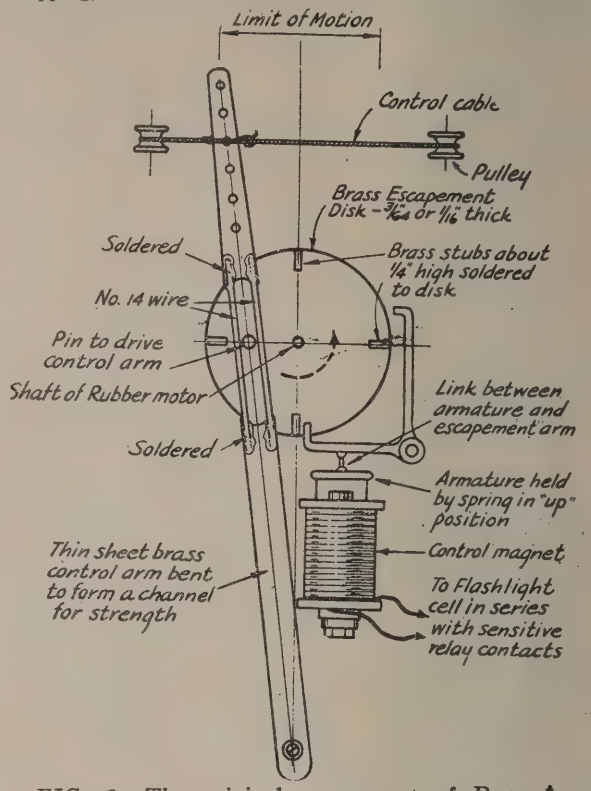

Limit of Motion
Control cable
Pulley
Brass Escapement Disk - 3/64 or 1/16 thick
Soldered
Brass stubs about 1/4" high soldered to disk
No. 14 wire
Pin to drive control arm
Shaft of Rubber motor
Link between armature and escapement arm
Soldered
Armature held by spring in "up" position
Control magnet
Thin sheet brass control arm bent to form a channel for strength
To Flashlight cell in series with sensitive relay contacts

FIG. 6.—The original escapement of Ross A. Hull. It will be seen to be of the second type.

breaking the circuit to brush No. 2. But when the key is released, the relay armature falls back and re-makes contact with the "homing" contact. The motor therefore runs again until No. 2 brush runs off the conducting segment of the wheel, when the motor stops. Thus, it can be seen that the wheel performs just the same movements as the escapement arm in the rubber-driven escapement, and that if we put a crank on the wheel shaft, this can be made to turn the rudder using the same kinds of linkage as are used with the escapement mechanism.

The motor-driven escapement we have just described, however, is able to do a trick that the rubber version cannot do. Supposing that the transmitter key is operated, and the motor starts. If the key is released *before* the wheel has done is 90° of movement, it can be seen that the motor will stop with the rudder partly turned in one direction. If the key is now pressed again, the movement continues, and if held on, the 90° movement will be completed. *Then* when the key is released, the homing mechanism comes into play again, and the rudder homes to the neutral position as described above. In other words, the motor-driven mechanism enables an "inching" action to be made in applying the rudder, and some measure of proportional control can be got. With the rubber escapement, the control is either full one way, or in neutral, there being no half measures at all.

ANOTHER KIND OF ESCAPEMENT

Both mechanisms that have so far been described are of the same basic type, in that they automatically return

the rudder to neutral after a "right" or "left" operation has been made. There is another type of rubber-driven escapement, which differs from the first kind only in that it is not self-returning. In other words, after "right" or "left" has been given by pressing the transmitter key and releasing it, the rudder stays in the selected position until a further signal is sent, returning it to neutral. This scheme has one advantage, namely that the turn is held on by the escapement without having to keep the current flowing through the operating coil. It is thus a little lighter on batteries than the self-homing type. However, experienced modellers assert that the slight extra drain of the self-homing escapement is well worth it, for this reason. In the system where a separate signal has to be sent in order to neutralize the rudder, it is possible, should control be lost, through the model getting out of range, for example, for this to happen while the rudder is set for a turn. In the case of a model aircraft, this could be disastrous, since if a turn is held on too long, it may result in the model spinning in, and becoming a complete write-off. With the self-centring scheme, however, any loss of the radio control does no positive harm, because the mechanism will automatically centralize the control, and the model proceeds quite happily as a normal uncontrolled model in free flight.

The non-returning escapement differs from the self-returning type only in having four sections on the escapement arm instead of two. This sort of thing is illustrated in Fig. 5. Here there is only one stop, which remains effective after the key has been lifted. The original escapement of Ross A. Hull is of this type, except for a second catch on the armature whose purpose is solely to prevent the rubber motor from "getting away," and performing several revolutions before the key is lifted, replacing the main stop. The Hull mechanism is shown in Fig. 6. It is complete with a reciprocating arm which drives the rudder through tensioned strings.

SOME POINTS TO WATCH WITH RUBBER-DRIVEN ESCAPEMENTS

First and foremost is the necessity for ensuring, before a model is sent off, that (*a*) the rubber motor is wound up, and (*b*) that the battery which works the solenoid is not run down; (*a*) constitutes one of the main arguments in favour of the motor-driven escapement, since it gives us one check fewer, and there is one thing fewer to go wrong.

The necessity for frequent winding of the rubber motor cannot be overcome by piling on more turns, because if this is done, the motor is too powerful at the beginning of its run, and the escapement wheel travels too fast. If this happens, it overrides the stops, and one loses the correct sequence of events. One method that is highly recommended for partially overcoming this defect of the rubber motor is to attach as large a vane of light balsa wood as possible to the wheel. This acts as an air brake, and tends to limit the speed at which the escapement wheel can turn. Then again, if the rubber motor is wound too tightly, the wheel presses so hard against the stops of the armature that more current than usual is needed to work the solenoid, which may refuse to function at all, or at best will draw much more out of the battery, and cause it to run down sooner than expected. From the foregoing, it can be seen that successful radio control of any model depends not only on having a mechanism that will work, but on careful checking of all parts of it in the field, and before every run, to see that one or more of the possible faults inherent in the system are not causing trouble. However, both rubber and motor-driven escapements of the Wright kind *can* be made sufficiently reliable for everyday use, as long as the operator takes care to lay down a checking procedure, and *carries it out.*

CONTROLS OTHER THAN DIRECTION

All those who have successfully operated radio controlled models are unanimous in their recommendations to the beginner to get a single directional control working first, and gain experience with it, before attempting simultaneous control of anything else. For example, with a model aircraft, it would be very nice, in theory at least, to have control not only of direction, but of height

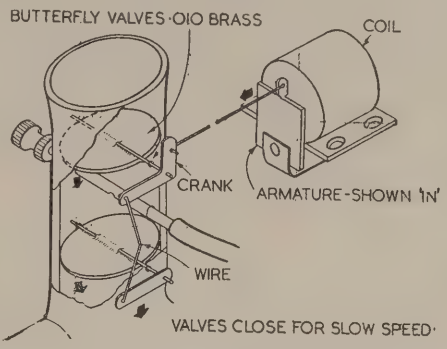


FIG. 7.—A method of using a solenoid to obtain two-speed running of a model I.C. engine.

also. In a powered model, it seems to be agreed that the best way of doing this is not to control the elevators, but to have a simple two-speed control of the motor. This is not easy to do with model motors, which are mostly organized in such a way that speed control cannot readily be done while the aircraft is in flight. However, one method that has been tried with success in America is illustrated in Fig. 7. It is a system of butterfly valves, operated simultaneously by a small solenoid. However, if it is possible to do something like this, it is quite a different matter to arrange for its remote control in addition to rudder without the use of a second communications channel. Mr. L. H. Wright has perfected a two-control system that works with only one radio frequency channel, and on which he is going to give us a descriptive article at a later date. Briefly, it is an extension of his present system (upon which the receiver described in this issue also works) in which two relays are used in the plate of the relay valve, and are wired in series. The normal relay-tube current is great enough to hold one relay in, but not the other. Then "carrier on" decreases the tube current and de-energizes the first relay, while *Modulated Carrier On* makes the tube pass more current than normal, keeping the first relay in, and bringing in the second one. Thus, two actuator systems can be operated, one from each relay. Mr. Wright has installed this system in a power-driven model aircraft, to give rudder and elevator control. We have seen it working on the ground, but as far as we know ,it has not yet been tested in flight. If the control of height were to be done by control of the motor speed, it would be possible to use the second relay to work a solenoid control such as that of Fig. 7, or in the case of a spark-ignition motor, to directly operate the two-position spark timing mechanism that can be installed on model petrol models.

While the present article does not pretend to exhaust the possibilities for actuator mechanisms, it has, we hope, given enough "gen" for those who are primarily radio men, and who wish to break into the model field in order to try out radio control, to build their own actuator mechanisms which complete the control gear once the receiver and transmitter have been built. Those

(Concluded on Page 48.)

NEW ZEALAND RADIO TRADERS' FEDERATION

At the Annual General Meeting of members held on the 15th March, 1950, the President, Mr. G. J. Markby, reviewed in his Annual Report a considerable amount of activity by the Federation during the past twelve months. Here are some extracts from the report:

"The new Government has been in office but a few short weeks and the effects of its policy have yet to be felt. Opinions have been expressed by prominent personalities in the industry that there lies before us a period of stable industrial and commercial conditions. Retailers can, I am sure, look forward with confidence to better trading conditions providing no major upheavals occur in the international field.

"An outstanding event for the industry was the decontrol of prices within the radio and electronic industry. The effect of the announcement, which was officially published in the *New Zealand Gazette* dated 3rd November, 1949, was to revoke price orders and approvals issued prior to 3rd November, 1949, in respect of goods and services within the radio industry; it freed members from the necessity of applying for approved price structures for radio and electronic goods, together with all related parts and devices. The announcement was the culmination of the work of the radio manufacturers and of your sub-committee which you appointed to handle the matter with the Price Control and the Price Tribunal. Widespread satisfaction has been expressed by the trade at the result, which demonstrated what could be achieved by collective action by members, and the advantages to be gained by radio dealers and servicemen being members of this organization."

National Broadcasting Service

The Annual Report of the New Zealand Broadcasting Service for the twelve months ending 31st March, 1949, presented to Parliament by the Director of Broadcasting shows that the National Division of the Service made a profit of £29,583 as against £126,903 for the previous year. Income from licence fees exceeded last year's figure by £20,356 and totalled £498,630 while revenue from the sale of time on the air recovered by £57,157 to £305,549 which is due to an easing in the restrictions on broadcasting hours for electricity conservation purposes.

The meeting occupied periods between 10 a.m. and 12.30 p.m. and from 2.30 to 5 p.m. approximately and during that time many varied and important matters were reviewed. Indications are that the new Federation Committee for the coming year will have a very busy time and the trade as a whole benefit by the deliberations of the meeting. Some matters dealt with were:—

Membership Badge

Two designs were brought forward for approval, and a motion was carried that a badge and transfers be procured and issued to members each year and that such a badge be registered and a set of rules be prepared controlling the use of the badge.

Bona Fide Radio Dealers

On a remit from Auckland it was decided to complete a register on a Dominion-wide basis, of *bona fide* radio dealers and servicemen and that an approach be made to wholesalers for their co-operation in refusing to supply at wholesale rates any person or persons not included in that register.

Members speaking to this remit said the objective was to do away with "back-yard" unregistered dealers and remove some of the dangers sometimes associated with repair work done at home in the evenings and back-yard methods. It was felt that the support to the proposal would be forthcoming from the wholesalers.

Mr. John Fairclough

Mr. Ivan Cosgrave

Special Committee

To deal with matters of urgency the following members were elected as an Emergency Committee: Messrs. D. B. Billing, W. I. Cunninghame, L. Lord, and S. D. Mason.

1950 Advertising Campaign

It was decided that the Federation should advise the Manufacturers' Federation that it would support the principle of a further advertising campaign and that an endeavour would be made to obtain the co-operation and financial support of the retail trade.

Guaranteed Receivers

This meeting re-approved the resolution made at the previous Annual Meeting that the maximum guarantee of 90 days be adhered to.

"Trade-in" Values

Much discussion took place on this die-hard question and Mr. Markby tabled an Australian hand-book which listed all the trade-in values of sets in Australia.

After discussion the following motion was carried: "That the question of a book of trade-in values for use

in New Zealand be taken up by the Executive and that the Executive draw up proposals for submission to Associations."

Mr. Fairclough expressed appreciation of the enthusiasm and efforts of Mr. Cattell, Assistant Secretary, in regard to the federation affairs.

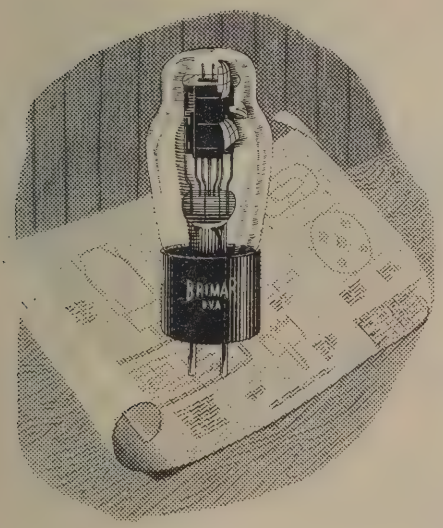
New President

Mr. John Fairclough of Napier has been associated with the radio trade since 1928, and is the type of pioneer of the industry who has taken many problems in his stride and come out on top. Members of the federation may look forward with every confidence to able administration under Mr. Fairclough.

Combining radio with his hardware business in 1928, Mr. Fairclough built up a profitable trade, employing eight of a staff, but the disastrous Hawke's Bay earthquake of 1931 meant a loss to him of £12,000 on which no insurance was paid. Attempts to re-establish this loss were not very successful until 1935 when the business was converted into a purely radio and household electrical appliances one, and the name changed to Fairclough Radio Ltd. Prosperity continued until World War II caused another setback. However, with a skeleton staff, Jack Fairclough kept going through this difficult period and now enjoys some of the fruits of his tenacity of purpose, being again well established and handling well-known radio agencies.

Apart from business, John Fairclough has much to interest him. He has always been associated with local activities, and is President of the Napier Retailers' Association, which office he has held for many years. A member of the Hawke's Bay Automobile Association since 1930, he was at one time secretary of that association. In sport John is a strenuous worker for the H.B. Football Association, and has served a term as its

(Concluded on Page 48.)



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1.4-volt Battery Types	1T4	1R5	1T4	1U5	3V4	—
6.3-volt Loctal Types	7H7	7S7	7H7	7K7	7C5	7Z4
6.3-volt Octal Types	6K7GT	6K8GT	6K7GT	6B8GT	6V6GT	5Y3GT
6.3-volt All Glass Types	6BA6	6BE6	6BA6	6AT6	—	6X4

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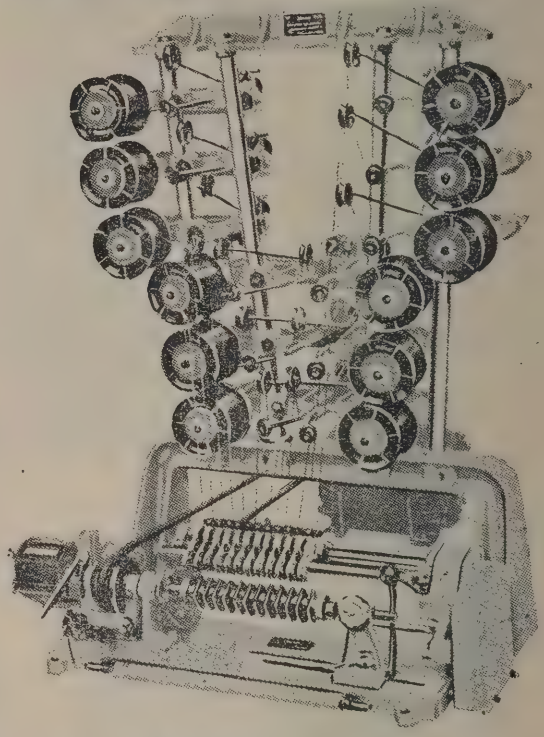
Multiple Winding



This machine is suitable for the winding of any number of coils from 2 to 12 at the same time.

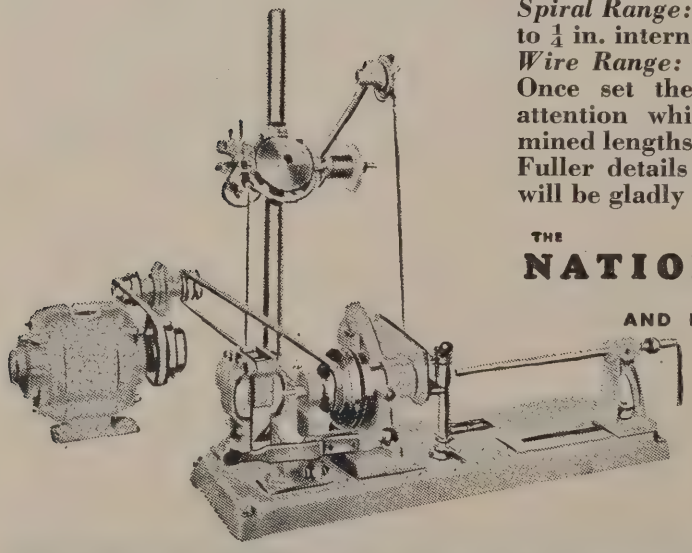
Coil Range: **Down to $\frac{1}{4}$-inch in length, and up to 4 inches in diameter, in round, square or rectangular coils.**

Wire Range: **From 50 s.w.g. to 16 s.w.g.**

Speed Range: **Adjustable to suit every gauge and speed range.**

The foot-operated clutch leaves the operator free to use both hands. As with all Douglas machines this winder is constructed on best engineering principles and is fast, accurate, and dependable.

Spiral Winding



This machine has been designed for winding long spirals for heater elements, control and switch-gear.

Spiral Range: **Up to 5 ft. in length and from 1/16 in. to $\frac{1}{4}$ in. internal diameter.**

Wire Range: **From 42 s.w.g. to 25 s.w.g.**

Once set the Douglas spiral winder requires no attention whilst running. Cutting-off to pre-determined lengths is semi-automatic.

Fuller details of these and other Douglas machines will be gladly supplied.

THE NATIONAL NEECO ELECTRICAL AND ENGINEERING COMPANY LIMITED

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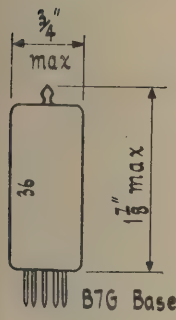
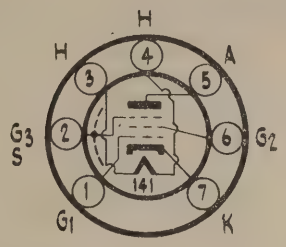
TUBE DATA

TYPE 6AT6, DOUBLE DIODE TRIODE





RATINGS

Heater voltage	6.3 volts
Heater current	0.3 amp.
Anode voltage	300 volts max.
Diode current	1.0 mA max.

OPERATING CHARACTERISTICS

Anode voltage	250 volts
Anode current	1.0 mA
Grid voltage	—3 volts
Anode impedance	58,000 ohms
Mutual conductance	1.2 mA/V
Amplification factor	70

OPERATION AS RESISTANCE COUPLED AMPLIFIER

Anode supply voltage	100	250	250	volts
Anode load resistor	0.5	0.25	0.25	meg.
Grid resistor	1.0	1.0	10	meg.
Cathode bias resistor	9,000	3,000	0	ohms
Peak output	16	43	40	volts
*Stage gain	33	42	42	
*Harmonic distortion	2	1	5	per cent.

*Figures are for 12 volts peak output.

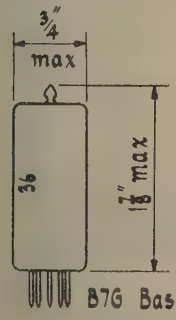
INTER-ELECTRODE CAPACITANCES*

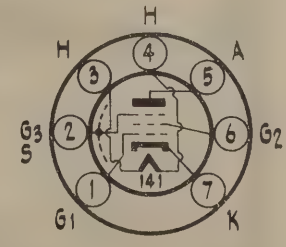
Grid to cathode	2.0 pF
Anode to cathode	1.1 pF
Grid to anode	2.1 pF
Diode (D2) to Grid	0.025 pF max.

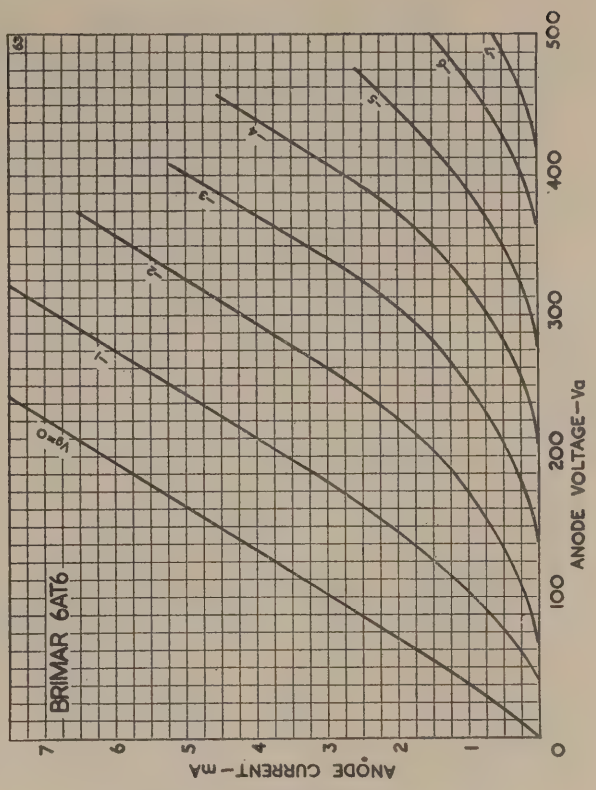
*With no external shield

TYPE 6AU6, HIGH SLOPE R.F. PENTODE

Type 6AU6 is a sharp cut-off pentode suitable for use as R.F. or A.F. amplifier, limiter or sync. separator.







RATINGS

Heater voltage	6.3 volts
Heater current	0.3 amp.
Anode voltage	300 volts max.
Anode dissipation	3.0 watts max.
Screen (G2) voltage	150 volts max.
Screen dissipation	0.65 watts max.

OPERATING CHARACTERISTICS

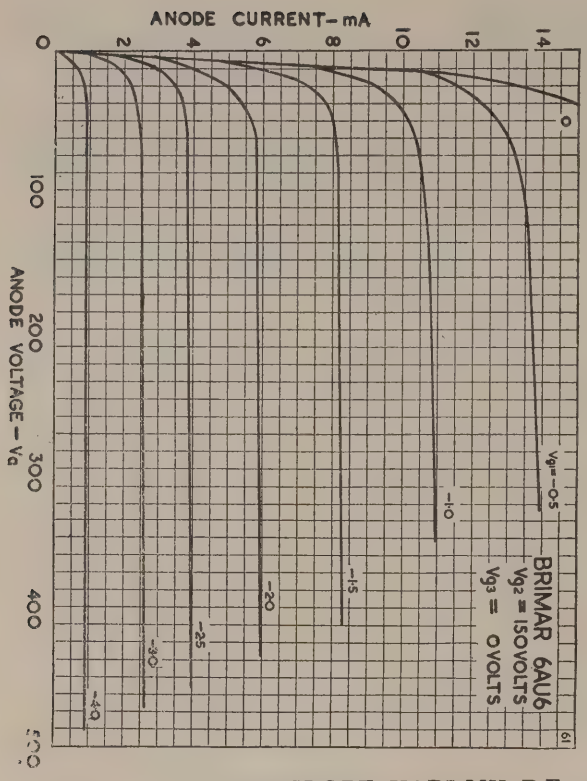
[Suppressor grid (G3) connected to Cathode]

Anode voltage	250	250	100	volts
Anode current	10.8	7.6	5.2	mA
Screen voltage	150	125	100	volts
Screen current	4.3	3.0	2.0	mA
Control grid (G1) voltage	—1	—1	—1	volts
Cathode bias resistor	68	100	140	ohms
Anode impedance	2.0	2.5	0.6	meg.
Mutual conductance	5.2	4.4	3.9	mA/V
Inner amplification factor (μG1/G2)	41	41	41	
Input impedance (50 mc/s)	3,500	—	—	ohms
Input impedance (90 mc/s)	900	—	—	ohms
Control grid voltage (For anode current cut-off).	—6.2	—5.2	—4.2	volts

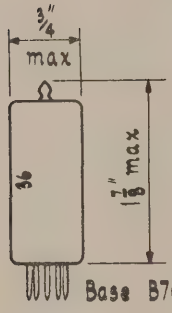
INTER-ELECTRODE CAPACITANCES*

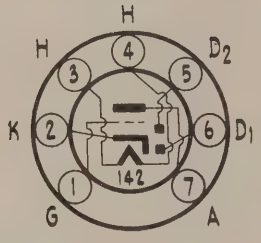
Input (Cge)	5.5 pF
Output (Cae)	5.0 pF
Grid to anode	0.0035 pF max.

*With no external shield.



TYPE 6BA6, HIGH SLOPE VARI-MU R.F. PENTODE





RATINGS

Heater voltage	6.3	volts		
Heater current	0.3	amp.		
Anode voltage	300	volts max.		
Anode dissipation	3.0	watts max.		
Screen (G2) supply voltage	300	volts max.		
Screen voltage	125	volts max.		
Screen dissipation	0.6	watts max.		

OPERATING CHARACTERISTICS

[Suppressor grid (G3) connected to Cathode]

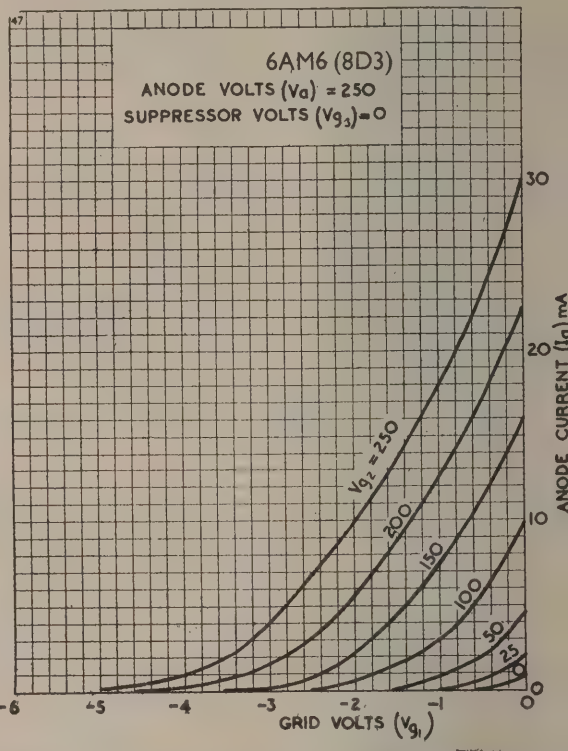
Anode voltage	100	250	250	volts
Anode current	10.8	11.0	11.0	mA
Screen voltage	100	100	—	volts
Series screen resistor	—	—	33,000	ohms
Screen current	4.4	4.2	4.2	mA
Control Grid (G1) voltage	—1	—1	—1	volts
Cathode bias resistor	68	68	68	ohms
Anode impedance	0.25	1.5	1.5	meg.
Mutual conductance	4.3	4.4	4.4	mA/V
Input impedance (45 mc/s)	4,500	4,500	4,500	ohms
Input impedance (90 mc/s)	900	900	900	ohms
Control grid voltage	—21	—21	—51	volts

(For mutual conductance of 0.005 mA/V.)

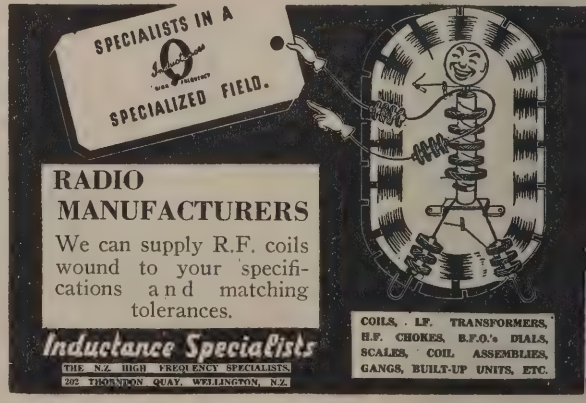
INTER-ELECTRODE CAPACITANCES*

Input	5.5 pF
Output	5.0 pF
Grid to anode	0.0035 pF max.

*With no external shield.



This curve for the 6AM6 was unavoidably omitted from last month's Tube Data.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Weight with cord, 7½ oz. Heating Time, 6 seconds

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F F F

A PORTABLE TRANSMITTER FOR RADIO CONTROL WORK

This small transmitter, with a power into the aerial of approximately three watts, is an ideal companion for the control receiver described elsewhere in this issue. It uses a single valve, and operates entirely from dry batteries.

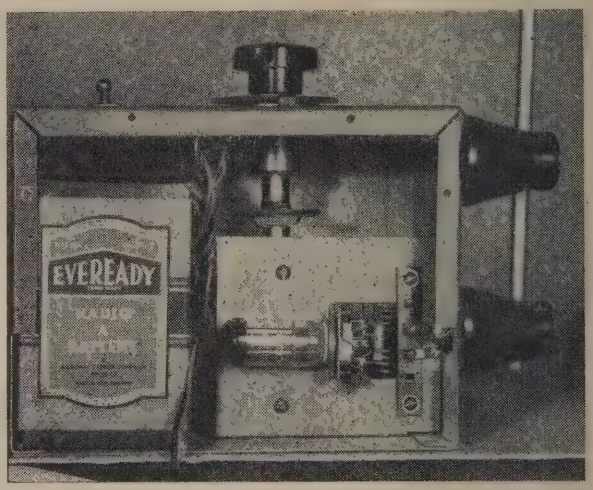
INTRODUCTION

Many of those who are taking an interest in radio control work want to know how much power is necessary in the transmitter, especially when model aircraft are to be controlled. The answer is to be found in the extreme sensitivity of the super-regenerative receiver that we have found to be standard, as far as such a thing can be, for such a novel purpose. Owing to the fact that the receiver will work perfectly from a signal of only a few microvolts, it can be imagined that the transmitter power required is very small, and such is indeed the case. However, there are a number of things that can reduce the sensitivity of the control system without the knowledge of the operator, and so it is advisable to have a substantial margin of transmitter power. For instance, if the receiver should go slightly off-tune, this would not necessarily be noticed in routine testing, since it is not always convenient to test the receiver at a great distance from the transmitter. Should this happen, it may be found that at a range not nearly as great as the normal maximum, control is lost altogether, or else becomes erratic. If plenty of transmitter power is available, however, slight de-tuning of the receiver is not likely to have any effect at short or moderate ranges, and accidents due to this cause will not be nearly so likely to happen. The same considerations apply, of course, to the transmitter tuning. In the field, it is very likely that some member of an enthusiastic crowd of onlookers may trip over the key leads, and jolt the transmitter, or he may even fall over the transmitter itself. However stoutly it is built, a self-excited transmitter is likely to go a little off-tune under conditions such as these, and here again, a reserve of transmitter power is an advantage.

A further cause of loss of control is the running down of dry batteries. Although these should be checked frequently—say before every run, one does not always remember to carry out routine checks, but the effect of receiver batteries which are near the end of their useful life will not be so badly felt if the transmitter is putting in a good, healthy signal. As far as the transmitter's batteries themselves are concerned, the output power when these are nearly run down will be greater if the initial power was greater.

Well then, we hear someone say, how much power *is* needed for reliable operation, and for guarding against unforeseen circumstances?

In our opinion, after some experience in the field, and after observing that of others, the 3 watts that the present transmitter will deliver is well within the safety margin that we have been recommending. The measured power output of Mr. L. H. Wright's transmitter is only 180 milliwatts. This is the one he uses on all occasions for working on the 52 to 54 mc/sec. band, and except for the odd time when his models get out of range, when he switches in extra H.T. batteries and increases the power somewhat, this expert never uses any more than this. By comparison, the transmitter we are about to describe is a veritable 2YA among control transmitters, but as we have said, one can rarely get into difficulties through using too much power, and even 3 watts is so small as to be unlikely to cause interference to anyone using the band for communication purposes.



View of the completed transmitter, showing the general arrangement of chassis and batteries, and the mounting of the aerial. One on the 67½v. Minimax B batteries stands upright behind the A battery, while the other is on its side behind the oscillator.

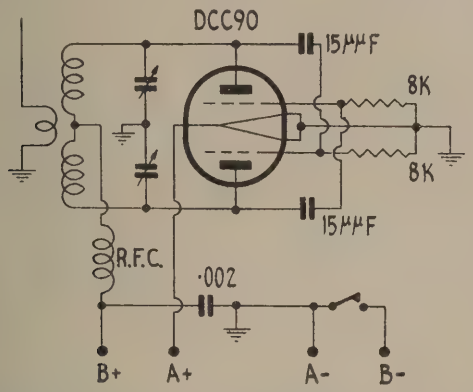
TYPE OF TRANSMITTER

In building a control transmitter, one has first of all to decide whether or not to use crystal control, an M.O.P.A., or a simple oscillator. In theory at least, crystal control would provide an ideal answer, in that there would be no worries as to whether or not one was working inside the allotted band; but in practice, a crystal-controlled transmitter is far from giving an ideal solution to the problem of what sort of transmitter to use. The main reason for this is the fact that accurate tuning of the receiver to the transmitter frequency is much more easily done by tuning the transmitter rather than the receiver. This is because the latter is much more inaccessible, and is also much more likely to suffer from hand capacity effects than the transmitter. Also, it is a simple matter to provide the transmitter with a good dial movement, which can be used in order to perform accurate tuning to the frequency of the receiver. With this arrangement, even if the receiver's frequency has been found to have shifted slightly, due to any cause, there is no necessity to get into the receiver to make adjustments, unless the shift has been great enough to take it outside the band, or unless the frequency shift has been great enough to put the set outside the portion where best super-regeneration is obtained. The transmitter can be solidly constructed, and quite stable as to frequency even if it is not crystal-controlled, so that its dial can be used to define the band limits. If a crystal-controlled transmitter is used, the only tunable thing in the whole system is the receiver. On account of the probability of hand capacity, it is unlikely that as accurate receiver tuning can be effected by altering the receiver

frequency, as by altering the transmitter frequency.

In this case, then, the choice boils down to either a simple self-controlled oscillator, or a more complex transmitter which perhaps uses a low-frequency oscillator and frequency multipliers, or an oscillator on the output frequency, followed by a straight amplifier.

The former has much to recommend it on the score of cost and simplicity, while the more complicated transmitter will bring its own advantages, in the shape of improved frequency stability under keying, and less frequency change due to people approaching the aerial rather closely. However, in the long run, the former considerations won. The receiver is likely to represent quite a large enough capital outlay, without having an expensive transmitter, and there is considerable virtue in keeping the latter as simple as possible, because there are more than enough things that can go wrong in the field without having to service a transmitter, should it go wrong.



Circuit diagram of the transmitter. The tuning condenser is a two-gang midget, 17½ μμf. max. capacity per section. For the 52 to 54 mc/sec. band, the tuning coil consists of eight turns of 16 gauge copper wire, wound on a ½ in. diameter former, with double spacing, and with a gap of ½ in. between the two halves. The aerial winding is two turns of the same wire, coupled in at the gap in the tank coil.

Also, as long as the aerial is not over-coupled, there is very little chance of enough de-tuning occurring in the field, to make the system inoperative. However, since a self-excited oscillator has been chosen for the purpose in hand, it follows that the greatest care should be taken with its construction, both from the point of view that one must not operate outside the allotted band, even by accident, and also from that of reliability. Nothing would be more calculated to spoil the fun to be derived from radio control than a transmitter which, through poor mechanical and electrical stability, is incapable of working the receiver consistently. Perhaps the worst feature of such a transmitter is that faulty operation would be very likely to be wrongly ascribed to the receiver!

CHOICE OF VALVE AND CIRCUIT

For portable equipment like this, it is important to choose a valve that is as light as possible on batteries, and in particular, the A battery. This automatically suggests the 1.4-volt miniature series, but here it is found that the best-known valves have only a very small allowable plate dissipation, and would therefore be able to provide a commensurately small output power. A valve in the miniature series, however, seems to be made for the job. It is the 3A5, which is a 1.4-volt double triode, especially designed as an R.F. oscillator or power amplifier at high frequencies. Unfortunately, this valve is not available, but inquiries elicited the fact that a British or Continental substitute is available. It is the DCC90, and it is equivalent in all respects to the 3A5. Its filament can be operated either at 1.4 volts, with a current drain of 0.22 amps, or at 3.0 volts, at 0.11 amps. This being the case, it is possible to use a single No. 6 cell, or even one of the smaller square A batteries in the transmitter. The latter, type No. 742, was chosen because of its smaller size, allowing it to fit into a small commercially available steel box, in which both transmitter and batteries were housed.

The DCC90 has a rated plate dissipation of approximately 3 watts, and so is easily capable of giving a power output of 3 watts at only moderate efficiency. In the present case, the input is 35 ma. at 135 volts, or 4.73 watts, and the measured output was 3 watts, giving an efficiency of 63.5 per cent., and a plate dissipation of 1.73 watts. Although the plate input may seem rather high for a valve of this sort, the figures speak for themselves, and it can be seen that the valve is working well within its capabilities in giving the output that it does.

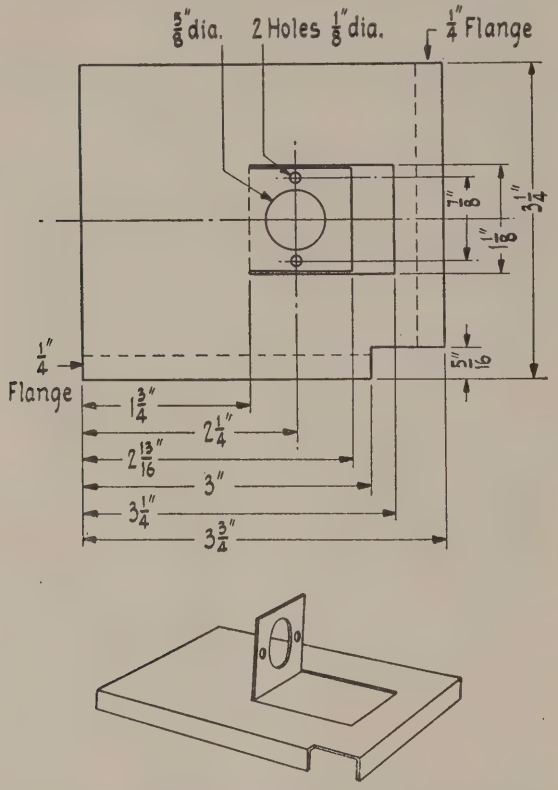
As can be seen from the circuit diagram, the arrangement is a very simple one. The tuned tank circuit is connected between the plates of the two halves of the valve, and the plates are coupled across to the opposite grids by the 15 μμf. blocking condensers and the grid leaks. The filament is run on 1.5 volts, thus avoiding the necessity for placing an equalizing resistor across the positive half of the filament, as needs to be done when series operation is used. In a push-pull oscillator, it is always a good thing to see that as far as possible, the two sides are balanced. For this reason, a split-stator tuning condenser is used, with the rotor earthed. Consequently, a choke is placed in the H.T. lead to the centre of the coil. This allows the centre-tap of the coil to "float", so that great accuracy in placing the tap is not required. The circuit will behave much better this way than if an ordinary condenser is used, and the centre of the coil by-passed to earth. This is purely because of the better electrical balancing obtained with the arrangement illustrated. The aerial is fed from a small two-turn coil coupled to the tank coil at the centre.

CONSTRUCTION

The chassis is made as shown in the two diagrams. The small one illustrates the manner in which the required bends are made. The flange, with the tube mounted on it, can be seen in the photograph, and a glimpse can be seen through the hole, of the coil. The midget two-gang condenser, which has a capacity of 7.5 to 50 μμf. is mounted on the back, behind the valve, and cannot be seen in the photograph. The coil is made from 16 gauge copper wire, and its ends are bent at right-angles to the last turns and soldered firmly to the stator lugs on the gang condenser. A gap is left between the two halves of the coil, and the coupling link is able to be bent far enough into the gap to get the required degree of coupling. The position of the gang condenser can be gauged by the direction of the tuning shaft in the photograph. A small dial with a reduction drive is fitted to the top of the case, and an extension shaft is used to reach that of the condenser, which is very short in the make used in the original. In order to support the free end of the plate choke, and also to provide an earthing lug, a small terminal strip is mounted behind the chassis, a convenient distance away from the coil.

The method of mounting the aerial is clearly shown

in the photo, and in our case consisted of the mounts belonging to a car-radio aerial. If these are not available (we just happened to have them handy) a pair of medium-sized feed-through insulators can be used instead. Or rather the top one can be a simple stand-off, and the lower one a feed-through since this is the one that takes the R.F. through the case to the aerial itself. It may surprise some to see common bakelite used here,



Above is a working drawing for the chassis, and below a diagram showing how the bends are to be made.

but it should be remembered that the bottom end of a quarter-wave aerial is a point of very low impedance, and therefore of low R.F. voltage, so that the quality of the insulating material is not as important as if it had been a voltage point. The photo also shows how handy the earth point on the chassis is to the aerial terminal. This is quite important, as it means that heavy R.F. currents do not have to flow through the chassis for more than a quarter of an inch or so. When it is realized that the aerial current is of the order of a quarter of an ampere, it can be seen that even a little resistance in the path the current has to take through the coupling coil could cause quite severe losses.

KEYING

In the circuit diagram, the key has been shown in the negative lead of the power supply. This is quite optional, as there is no reason why it should not be placed in the positive lead if desired. Do not be lulled into a false sense of security because the key is in the negative lead, and the H.T. voltage is only 135! Batteries can give the nastiest "nip" imaginable, and the B— lead is actually 135 volts above ground when the key is open. If an ordinary morse key is used, this should either be of the shielded variety, or else should be completely insulated. However, a rather better idea is to use a P. and T. type of self-returning press switch instead of the key. This can be installed in a narrow box, say ¾ in. square, and just long enough to hold the switch. At one end the press button protrudes, while at the other is a rubber grommet through which the leads enter. With this type of switch, there is no possibility of getting a sock.

AERIAL

As mentioned above, the aerial decided upon for the transmitter is a vertical quarter-wave, or Marconi aerial. This was chosen for a number of reasons. In the first place, it is reasonably short, being only 55½ in. long at 53 mc/sec., the centre of the radio control band. In practice, it will be shorter still, since the coupling loop, in series with the lower end of the aerial makes the resonant length rather less than the actual quarter wavelength quoted. In general, a Marconi aerial (which is the type used for broadcast transmitters) needs an extensive earth system for efficient radiation, but no such worries occur with the frequencies we are talking about at present. It is not even necessary to use an earthing spike, and all that is done is to sit the transmitter on the ground. The capacity to earth from the case is quite large enough at the frequency in use to act as an efficient earth, and thus to allow the aerial to radiate efficiently. However, when the aerial coupling is being adjusted, it is essential to have the transmitter actually on the ground. The same applies to the adjustment of aerial length, because if the whole thing is inside a building, and some distance from the ground, the behaviour is somewhat different from usual, and the best adjustments will not necessarily be the same with the transmitter on the ground, which is where it will work in practice.

ADJUSTING THE AERIAL LENGTH AND COUPLING

When the circuit has been constructed, and it has been seen that it functions (as judged by coupling a dial lamp into the tank circuit with a two-turn link) the first thing will be to check that the frequency range is correct. This should be done with a wave-meter, and the dial readings noted for the ends of the 50 to 54 mc/sec. amateur band, and for 52 mc/sec. as well. The 52 to 54 mc/sec. radio control section of the band should occupy about ten to fifteen divisions on a 0 to 100 dial marked over 180°. Then one takes the transmitter, the aerial, and, if possible, an R.F. milliammeter, out into the garden away from buildings as far as possible. The theoretical length of aerial can, as explained above, be only a rough guide to the actual length that will be needed. A simple method of varying the aerial length, and one that was used with the original transmitter, is to make the lower portion of the aerial of brass tubing (say ¼ in. outside diameter) and the rest, of ⅛ in. brass rod. The latter will not be a snug fit into the lower part, but can be made so by putting a slight curve in the portion that is to be slid into the lower tubing. Only about 20 in. of tubing was used, and this was left permanently attached to the transmitter. Then, for transport, the upper part of the aerial can be removed, making the whole thing portable without the necessity for unscrewing the aerial from its mountings.

First of all, the two-turn coupling loop is coupled very loosely to the tank coil of the oscillator. If an R.F. milliammeter is not available, a D.C. meter can be used as an indicator instead, by inserting it temporarily in the key lead. If one has the R.F. meter (0–100 ma. is suit-

able) this can be provided with short leads and a pair of alligator clips, and then be connected across about two inches of the aerial right at the bottom. The R.F. meter acts directly as an output meter, while the plate meter can be used by taking note of when, and how much, the plate current of the oscillator rises as the aerial is brought into resonance.

Having rigged either of these indicating devices, one can proceed in either of two ways. Perhaps the best is to choose a likely length of aerial, say, 50 inches, and then tune the oscillator until a rise of plate current, or a reading on the R.F. meter, shows that the transmitter has been brought into tune with the aerial. For this, as mentioned before, the aerial coupling should be as loose as possible, so that the aerial will not pull the oscillator frequency. Only enough coupling should be used to give an easily distinguishable deflection to the meter. If a rough calibration of the oscillator dial has been done in the absence of the aerial, as suggested, we now note the dial reading at which the transmitter came into resonance with the aerial. If this is lower than the desired operating frequency (say 53 mc/sec.), it means that the aerial is too long, and must be shortened. This is done by pushing the rod into the tube a few inches (two or three will be plenty) and the dial is spun again until resonance is found once more. The process is continued until the peak plate current or R.F. current occurs when the dial is exactly at the point where 53 mc/sec was found in the calibration. As long as the coupling is loose enough, the calibration will have held, even though the aerial is now present, and we can now start to increase the coupling. This is done until the plate current is 35 ma., or until the R.F. meter reads approximately 50 ma. when tapped across a couple of inches of the bottom of the aerial. Then, the dial is turned once more, to see if the coupling has not been overdone. If it has, the result will be shown up by the existence of two peaks in the response as the oscillator is tuned. If the plate current cannot be raised quite to 35 ma. without bringing the two peaks into evidence, then the coupling should be backed off until only one peak is left. If the coupling is too tight, not only will the frequency of the oscillator be changed when people move round the vicinity of the aerial, but also the oscillator will be liable to jump from one frequency to another, and when keyed, it may hop from the frequency of one peak to that of the other, without warning. Should this happen, loss of control would be the only evidence of it, and it would be a difficult fault to track down. It is much better to put a little less current into the aerial and know that the frequency cannot jump. If the aerial is adjusted for best results on 53 mc/sec., the centre of the band, it will not be really necessary to re-adjust the aerial coupling or length when changes are made to the frequency within the band. Thus, after

(Continued on page 48.)

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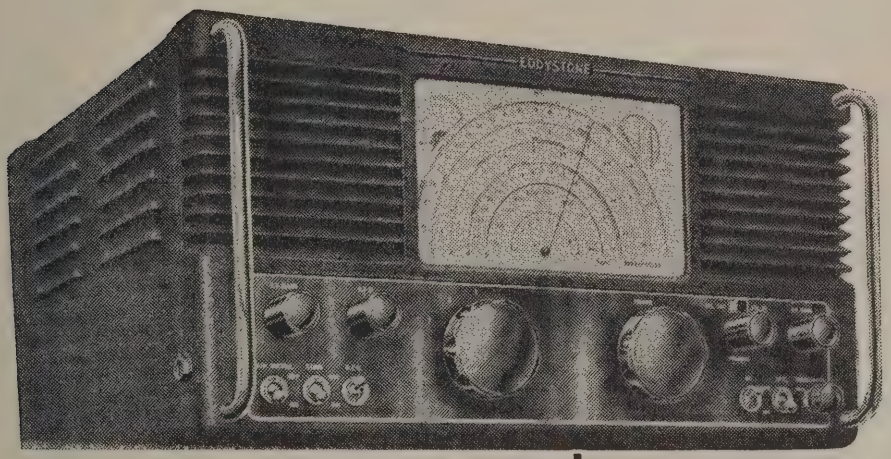

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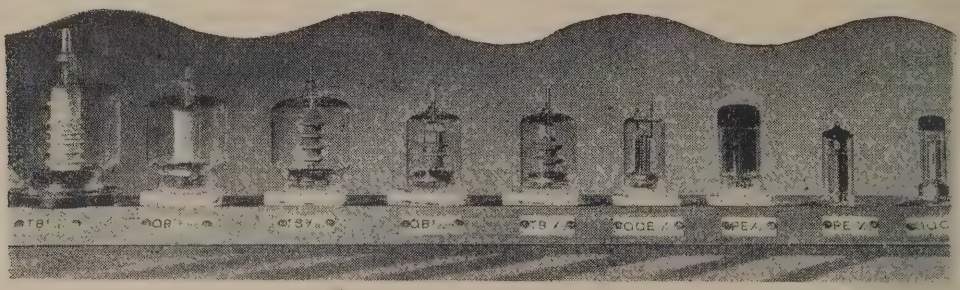
The PHILIPS Experimenter

NO. 31: SOME OF THE NEW PHILIPS RANGE OF TRANSMITTING VALVES



Pictured above is the latest range of Philips transmitting valves, which are of modern design and construction, and which are useful over a wide range of output powers and frequencies. Many of them are plug-in equivalents of American type transmitting valves, and as such will be known already to users and designers of transmitters. Others again have no direct equivalents in the American range of valves, but should be able to make their own particular appeal, strictly on their merits. Most of them are of the new Philips all-glass construction, with the sintered glass button base, and even where the main electrical characteristics are similar to those of an American type, this form of construction shows the Philips equivalents in a very favourable light, particularly with regard to very-high and ultra-high frequency application.

THE QQE06/40 AND THE QV04/7

Readers of the Philips Experimenter will already be familiar with these types, since they have been featured in the transmitter for the 80, 40, 20 and 10 metre bands that has been described in these pages over a period of several months. The former is an exact replacement for the 829B, with the added advantage of ratings up to 300 mc/sec. It has most excellent properties for use on the V.H.F. part of the radio spectrum, and recent experimental work undertaken in our laboratories has shown it capable of excellent performance, under reduced ratings, of course, even at 420–450 mc/sec., where the lowest of the U.H.F. amateur bands is situated. In this connection, we might mention that very useful output on this band is to be had by using the QQE06/40 as a push-pull tripler, with drive provided by a single QV04/7 operating as a straight amplifier on the band 140–150 mc/sec. It is thus a comparatively simple matter to achieve crystal control on the 420 mc/sec. band, with the aid of the two valves we are considering. The output power has not yet been measured accurately, but with an input to the plate circuit of only 30 watts, the output appears to be as good as that obtained from a door-knob tube (316A) operating as an oscillator with approximately the same input power.

The QV04/7 makes an excellent straight amplifier or frequency multiplier at output frequencies up to 150 mc/sec. For example, as a doubler on this frequency, it will give 2.3 watts output at an efficiency of 25 per cent., while tripling from 50 mc/sec., the output obtainable is 3.1 watts at an efficiency of 19 per cent. As a straight amplifier on 150 mc/sec., an output of 6.3 watts is obtainable at an efficiency of 45 per cent. At lower frequencies, it is capable of 8.1 watts output at 62½ per cent. efficiency, so that the valve can be seen to have very great possibilities in the low-powered stages of transmitters of all kinds. Its rated plate dissipation is 7.5 watts, and it is particularly suitable for use in mobile transmitters, in which it has already found wide application in this country.

The QQE06/40 is a twin beam tetrode, specially suited to push-pull circuits, either as a straight amplifier, or as a frequency tripler. It has a built-in screen bypass condenser of 60 $\mu\mu$f. This condenser is returned to the cathode inside the envelope, and helps to ensure that proper screen bypassing is secured at very high frequencies. It lends itself particularly well to the use of line circuits, and its internal shielding is so good that it may be used at least as high as 150 mc/sec. without neutralization. However, in order to secure stable operation, it is essential to shield the input and output circuits from each other very carefully. In addition, a single earth point should be used for the stage, in order to avoid undesired coupling through R.F. currents in the chassis.

Its plate dissipation is 40 watts. Below 150 mc/sec. natural cooling is suitable, but above this frequency, low-velocity air cooling of the bulb must be employed if the valve is operated at full ratings. It may, with this proviso, be operated as high as 400 mc/sec. with full rated plate dissipation, and at this frequency, will give an output of 40 watts with an overall efficiency of 45 per cent. For a valve of its physical size, this U.H.F. performance is phenomenal, and there seems no reason why the valve should not be operated on the 420–460 mc/sec. band at reduced ratings. As can be expected, the performance of this valve at lower frequencies leaves little to be desired. The performance at frequencies up to 60 mc/sec. is identical at all frequencies, and it may be interesting to give a summary of working conditions under representative classes of service. As a push-pull straight amplifier, we have:—

Plate volts, 600.	Screen volts, 250.
Plate current, 200 ma.	Screen current, 18 ma.
Grid bias, —100v.	Grid current, 3 ma.
Power output, 86 watts.	Efficiency, 71 per cent..

As a frequency tripler from 50 to 150 mc/sec., we have:—

Plate volts, 500.	Plate current, 120 ma.
Screen volts, 250.	Screen current, 10 ma.
Grid bias, —150v.	Grid current, 6 ma.
Power output, 20 watts.	Efficiency, 33 per cent.

These figures give some idea of the extremely wide variety of uses to which this valve may be put. At the lower frequencies, it would make an excellent push-pull doubler, as well as the applications illustrated above.

THE QB3/300 AND THE TB2.5/300

These two valves will be new to most readers of the Experimenter. They have much larger plate dissipations than the valves already described, but their diminutive physical size makes both of them ideal for V.H.F. applications where larger amounts of power are required. The former is a tetrode, with a plate dissipation of 125 watts, while the latter is a triode, and its plate dissipation is slightly larger, at 135 watts. Both valves use the now familiar all-glass construction, with the sintered button type of base. Both are directly heated, with thoriated tungsten filaments. The QB3/300 can give an output of 220 watts at 100 mc/sec., with a plate voltage of 2000, and an output of 155 watts at the same frequency, with only 1500 volts on the plate. The screen requires a supply of 500 volts. In addition to its use as an R.F. amplifier, this valve makes an excellent Class B_1 audio amplifier valve, and a pair of them are capable of developing 250 watts. Since there is no grid current, no driving power is required, and a grid-to-grid voltage of only 150 is required for the above output. For higher output, the QB3/300 can be operated at 2500 volts on the plates, in Class B_2, when a driving power of 5.7 watts gives an output of 510 watts. Under these conditions, the efficiency is 73 per cent.

The TB2.5/300 is, if anything more versatile than its tetrode mate. It can be used as an amplifier or frequency multiplier up to 150 mc/sec. and is suitable for both conventional and grounded-grid circuits. It can also be used as a Class B_2 audio amplifier, in which service a pair will give 800 watts output, for only 10.5 watts of grid drive.

As a Class C R.F. amplifier, the valve can deliver 425 watts with only 2000 volts on the plate, and at this is capable of 100 per cent. plate modulation.

(Continued on Page 30.)

17 GUINEAS buys this
NEW PHILIPS RECEIVER

PHILIPS

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The BIG set with
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A glance at the specifications tells every radioman that this new PHILIPS radioplayer is an out-of-the-ordinary performer. Combine that with its outstanding value, and you have a set with an exceptional and instantaneous demand.

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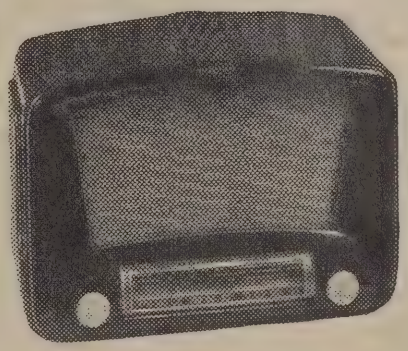
17 GUINEAS



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By A. G. THOMSON

(English journalist and feature writer who has specialized in technical subjects)

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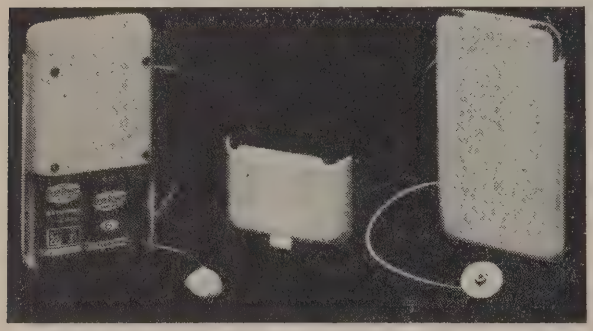

Though weighing only eight ounces the "Auratone" as it is called, is a four-valve super-heterodyne receiver of precision engineering construction. High-quality reception is achieved by means of a super-sensitive featherweight crystal earpiece which rests in the ear without discomfort, shutting out all extraneous noise and giving a true balance of sound almost impossible to attain with a loud-speaker. This inconspicuous device enables the listener to enjoy his favourite programme without embarrassment while walking, shopping or travelling, the receiver taking up no more room than a large cigarette-case in a pocket or a women's handbag. A truly personal possession, the instrument can be switched on anywhere and listened to in absolute privacy. Two controls with fingertip action are provided, one for tuning to the desired wavelength and the other for adjusting volume and switching the instrument on and off.

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The chassis, components, and batteries are contained

(Continued on Page 47.)

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The *Radio and Electronics* Abstract Service

AUDIO EQUIPMENT AND DESIGN

An entirely resistance-capacity coupled feed-back amplifier, which has high-pass, low-pass, or band-pass frequency response, can have useful advantages compared with amplifiers incorporating conventional filters.

—*Wireless Engineer* (Eng.), January, 1950, p. 26.

CIRCUITS AND CIRCUIT ELEMENTS

A description is given of some circuits for the generation of rectangular pulses of variable duration, applicable to speech transmission and a derivation of the basic circuit serves to convert the length or width modulation into pulse position or displacement modulation. The apparatus is sufficiently simple to be built into signal generators, and pulse parameters are readily available.

—*Wireless Engineer* (Eng.), January, 1950, p. 12.

ELECTRONIC DEVICES

(1) The electronic torch is hot enough to melt tungsten and is produced by r.f. heating of certain gasses; (2) Ultrasonic echoes are used to detect gallstones or other solids in the human body; (3) The zirconium arc light maintains a pool of the metal at 6,500°F. producing a uniformly dazzling light for special uses.

—*Electronics* (U.S.A.), February, 1950, p. 120.

Make your own self-generating photocell. Many interesting devices, burglar alarms, "customer announcers," counting devices, etc., can be devised from a small selenium rectifier. A description given of the home-made cell using a microampere-meter as indicator.

—*Radio and Television News* (U.S.A.), Jan. 1950, p. 50.

Description of a high sensitivity photometer useful for low intensities of illumination such as those of astronomical photometry which makes a valuable research tool from a relatively inexpensive telescope.

—*Electronics* (U.S.A.), February, 1950, p. 89.

Voice-operated switching of carrier systems. A new all-electrical transfer unit, fast enough to permit break-in between words, provides satisfactory two-way or party line communication over power line or radio carrier systems using a single frequency.

—*Electronics* (U.S.A.), February, 1950, p. 92.

MATERIALS AND SUBSIDIARY TECHNIQUES

The demand for means of pulse production at high repetition rates has produced permalloy coils which induce pulses well below a tenth of a microsecond duration with repetition rates up to a few megacycles.

—*Proceedings of the I.R.E.* (U.S.A.), Jan., 1950, p. 40.

A discussion of the techniques and equipment used in making printed circuits for home-built units. The simple brushing of conductor and resistor paints on to a base is the most practical way to start experimenting. Conductor and resistor paints are now available in U.S.A.

—*Radio and T.V. News*, Jan. 1950, p. 53.

The structure and properties of permanent magnet alloys—the reactions occurring in the formation of the alloys is described, and their use in electronics.

—*Electrical Engineering* (U.S.A.), January, 1950, p. 37.

Thyrite is a ceramic-bonded resistance material characterized by its non-linear resistance and passes a current proportional to a relatively high exponent of the applied voltage. It has special use in power transformers for shunting high surge currents.

—*Electrical Engineering* (U.S.A.), January, 1950, p. 52.

A study of thermisters, or resistors subject to wide variation with temperature. One of the uses is in connection with new carrier telephone systems.

—*Proceedings of The I.R.E.* (U.S.A.), January, 1950, p. 20.

Details of techniques by which the phospor coating of a television picture tube is covered by a membrane on which a thin mirror-like coating of aluminium is evaporated and removed by heat before final evacuation.

—*Electronics* (U.S.A.), February, 1950, p. 76.

A gated beam tube is described in which the electron beam passes through two control grids each of which has unusually steep and linear transfer characteristics. The tube is especially suited for use as a f.m. limiter-discriminator circuit, as a sync separator or square-wave generator.

—*Electronics* (U.S.A.), February, 1950, p. 82.

MATHEMATICS

Calculation of filter circuits—debunking the cosh or hyperbolic functions. Non-mathematicians will find this most helpful.

—*Wireless World* (Eng.), February, 1950, p. 61.

Equations and easily read charts give optimum ratios of inner and outer conductor diameters for each of ten different transmission line properties. Expanded scales give Zo for any ratio.

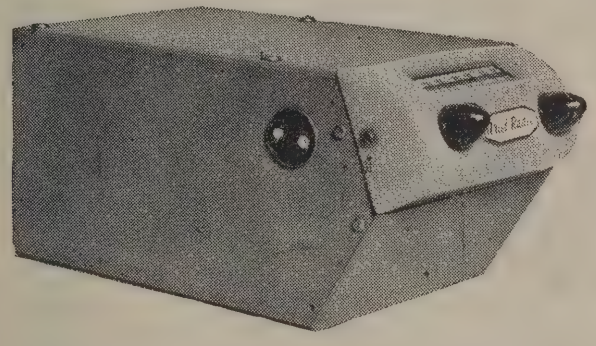
—*Electronics* (U.S.A.), February, 1950, p. 111.

PROPAGATION

Lenses for wave direction in the nature of optical lenses may be constructed of metal plates in variation formations. These lenses have exceptional wide-angle scanning properties.

—*Proceedings of The I.R.E.* (U.S.A.), January, 1950, p. 53.

NEW CAR RADIO KITSET



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A review of sunspot activity and ionospheric conditions. Past measurements of sunspot activity and ionoscoperic critical frequency with particular reference to the changes which occurred in 1949, and to those which may occur in 1950.
—*Wireless World* (Eng.), February, 1950, p. 53.

What is Stratovision? It is airborne television transmission relay from planes in motion at high altitudes. By raising the broadcasting antenna to greater heights large improvements are obtained. At 30,000 ft. the "line of sight" is 211 miles. A description is given of an experimental "Stratovision" plane.
—*Radio and Television News* (U.S.A.), January 1950, p. 37.

A review of the present state of knowledge of the speed of transmission of radio waves under practical conditions—velocity of light and radio waves in a vacuum, and in various conditions of the earth's atmosphere.
—*Proceedings of The I.R.E.* (U.S.A.), January, 1950, p. 16.

RECEIVERS

A comprehensive study of noise interference with reception. Test apparatus, including noisemeters described, the factor of "annoyance" to the listener being a prime factor.
—*Wireless Engineer* (Eng.), January, 1950, p. 2.

The introduction of Raytheon's new CK-703 crystal triode, a transistor, on the commercial market opens up new fields. The article describes a simple crystal diode broadcast receiver with a crystal triode audio amplifier. It will not operate a speaker but gives a large signal for a headset. The design provides for a crystal detector and three CK-703 transistors. After much talk of the germanium transistor it is indeed interesting to see a practical design for a receiver.
—*Radio and Television News* (U.S.A.), January 1950, p. 38.

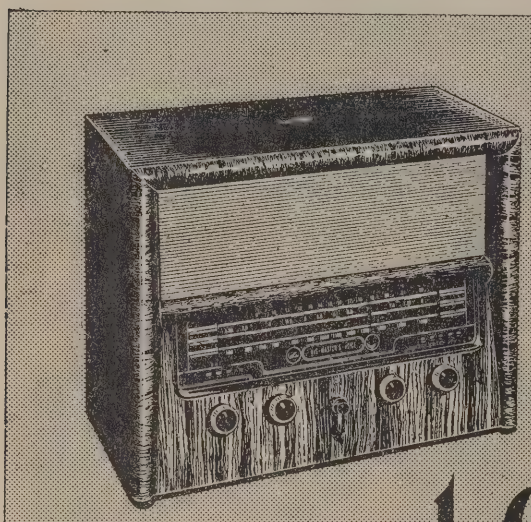
TEST APPARATUS AND MEASUREMENTS

Two bridge circuits for impedance measurements at very high frequency are described. The first is a hybrid junction tuneable over the 100–500 m.c. range and capable of great sensitivity. The second is an untuned Wheatstone type for service over the same range.
—*Proceedings of the I.R.E.* (U.S.A.), January, 1950, p. 37.

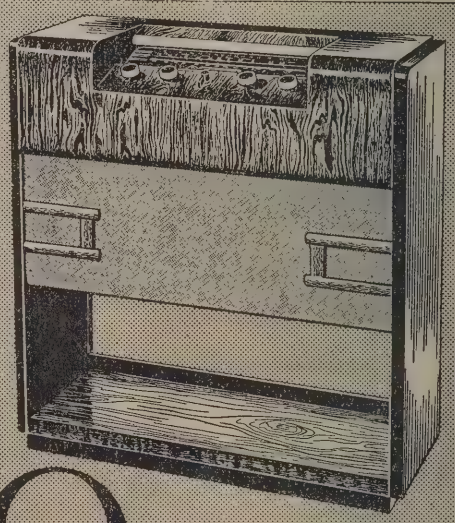
MISCELLANEOUS

The construction is described of two separate variable high-voltage power supplies ranging from 5 to 30 k.v. with 0.05 per

(Continued on Page 48.)



Canterbury 8 valve mantel model radio.



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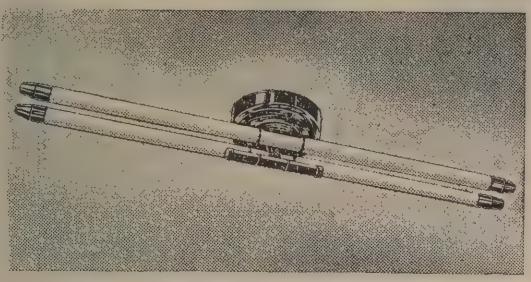
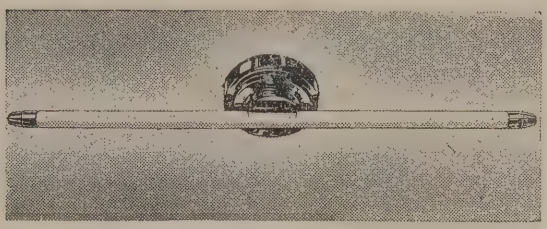


Model D.2 Chrome Ornamental



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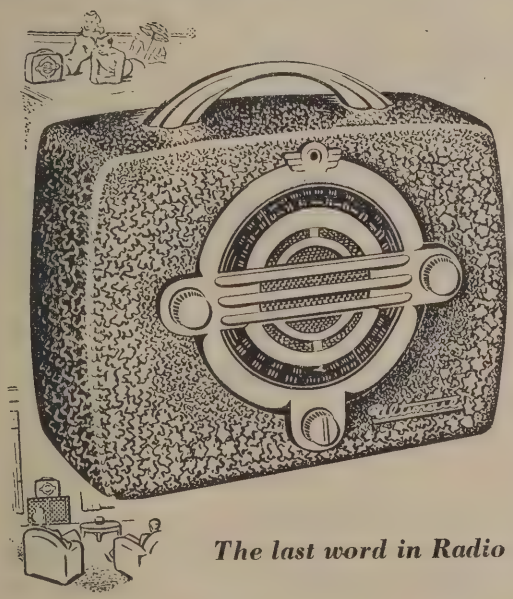

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ULTIMATE

Manufactured by **RADIO (1936) LTD.** *QUAY STREET, AUCKLAND*

PHILIPS EXPERIMENTER

(Continued from page 25.)

SOME OTHER VALVES

Mention has already been made of the QQE04/20. This is a double tetrode, built on very similar lines to the larger QQE06/40. It may be used as a direct replacement for the American type 832, and has all the advantages of the larger valve, including a very high maximum frequency. The QQE04/20 is able to deliver an output of 23 watts at 150 mc/sec., with only 400 volts on the plates. At 300 mc/sec., and a plate voltage of 360, its output is eleven watts. This valve also will act as a successful push-pull frequency tripler giving output on the 420 to 450 mc/sec., but with considerably less output than the QQE06/40.

Another double valve that will be of particular interest to amateur transmitters is the QQE04/40, which is equivalent electrically and physically to the popular 815. It is useful up to quite high frequencies, but not as far as the QQE04/20 or the QQE06/40, as is only to be expected from its construction, which follows conventional practice more closely than that of the other two types. However, at frequencies up to and including the 150 to 154 mc/sec. band, its performance is excellent. With a plate voltage of only 500, and its rated plate dissipation of 25 watts, this valve can give over 50 watts of output at frequencies up to 125 mc/sec. At 175 mc/sec., it may be used at 80 per cent. of its maximum plate voltage and dissipation, while at 200 mc/sec., these ratings are reduced to 70 per cent. of maximum. We have not yet conducted experiments with a view to finding out whether this valve will function at 420 mc/sec., but it is hardly to be expected that its performance would be good enough at such a high frequency. We hope to make some tests along these lines as soon as possible, and the results will be incorporated either in Philips Application Notes, in the Experimenter, or possibly in both. The QQE04/40 is also an excellent performer as a Class AB_2 audio amplifier, in which service it can give 54 watts of audio output. A suggested use for this valve is as both final amplifier and Class AB_2 modulator in the same medium-power transmitter.

Still another valve of the double tetrode type is the QQC04/15. This has a standard Loctal base, and is single-ended, all elements being brought out to the base pins. It is constructed very similarly to the QQE06/40, in that it uses a common filament (it is directly heated) with the control and screen grids of the two halves built in a single structure, which supports the elements for the two halves on opposite sides of the filament. The outstanding feature of this valve is that it has a rapid-heating filament, and is intended for use in mobile equipment, where it saves the continuous drain on the battery imposed by heater-cathode types of valve. From the moment of switching on, the valve is fully heated in three seconds. It is possible to use the two sections as separate entities, so that several valves of this type may be used in the same transmitter, the sections of one or more of them being used quite independently. It is thus possible to design a mobile transmitter which imposes virtually no drain on the power supply in the "stand-up" condition, and yet is ready for use at three seconds' notice. As an indication of its usefulness in addition to its versatility, it may be stated that this valve will deliver 19.5 watts at 186 mc/sec.

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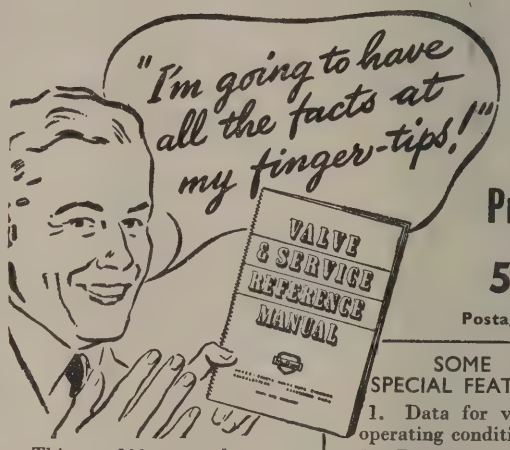

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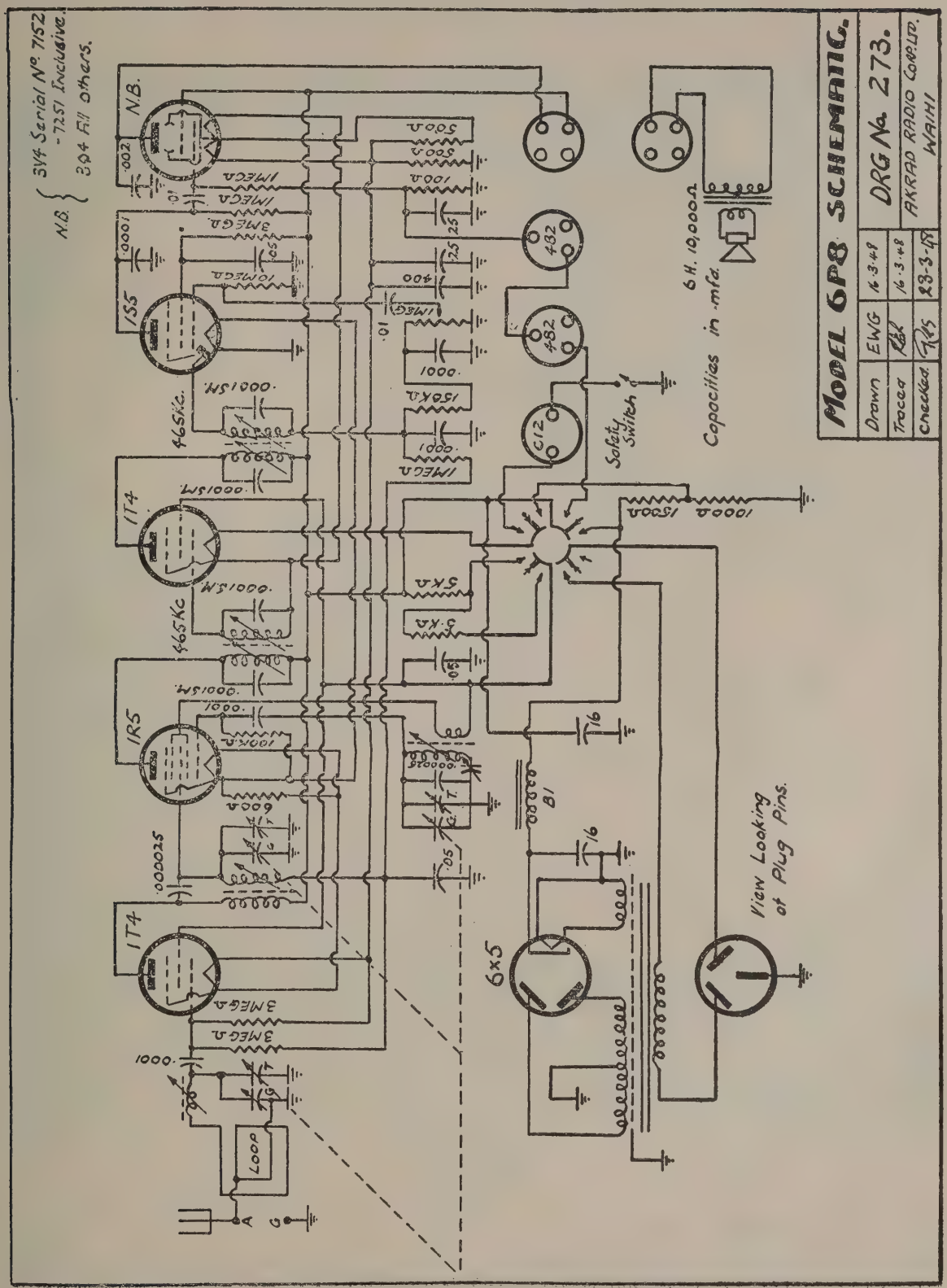
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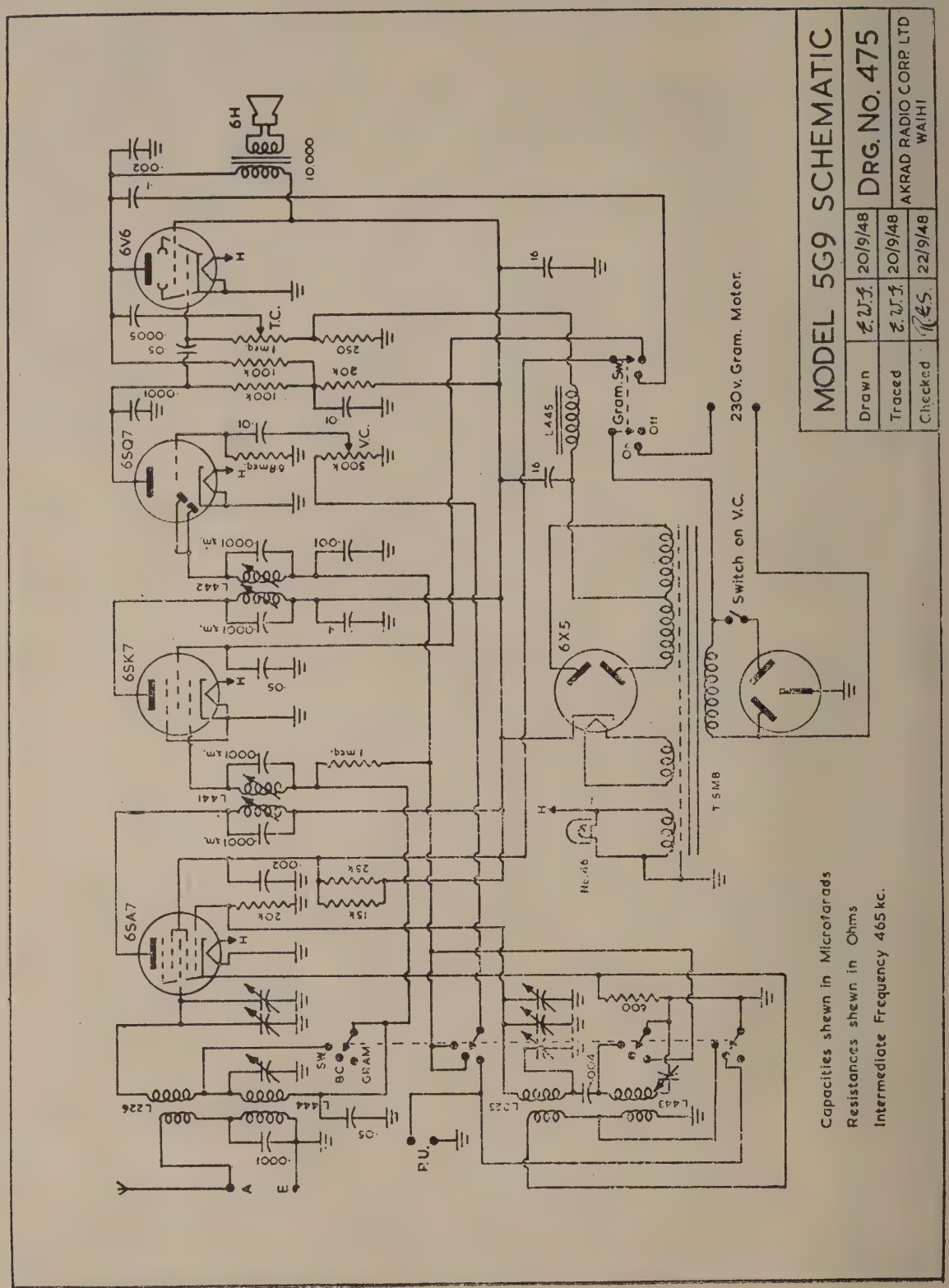
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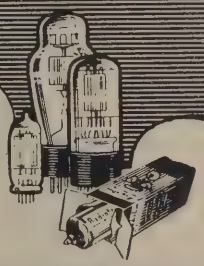

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The New Zealand Electronics Institute (Inc.) Newsletter

COUNCIL NEWS

At the date of going to press a Council meeting has been convened for April 22nd, and further progress in regard to membership certificates, insignia, examinations, and other matters should be available in the next issue.

Wellington Branch:

Mr. W. D. Foster, B.Sc., A.M.Brit.I.R.E., M.N.Z.E.I., recently delivered a talk entitled "Further Aspects of Modern High Quality Audio Equipment," which was a continuation of the one presented at the October meeting.

Mr. Foster opened his speech with a description of the dynamic noise suppressor, stating that the object of the system was to eliminate high frequency hiss or scratch and low frequency rumble. After covering in detail the fundamental principles, he proceeded to describe the method of achieving this result. This was done by means of a high frequency, and a low frequency gate, together with their associated rectifier and filter circuits.

The second phase of Mr. Foster's address dealt with the problems of high fidelity reproduction. He pointed out that increasing the frequency range of the system was useless unless distortion and noise were first considerably reduced. Quite a number of interesting points were raised by the speaker, one being "How much power is required for the average sitting room?" His answer was that an amplifier should have a reserve of power of at least 6 db. at all frequencies within the useful range of the equipment above the level which gives comfortable listening. After considering points about the Williamson method of reducing distortion, he proceeded to describe Hilliard's approach to the subject. The test procedure was first to make power output tests at many frequencies over the full range of the amplifier; second to take several response curves at constant input level, 10, 20, and 30 db. down on the maximum power output at 1000 cycles, and third to measure the intermodulation products. This to be done by feeding two oscillators into a linear mixer through an attenuator and a high pass filter to the input of the amplifier, and its output to be connected to a percentage modulation meter. This test to be conducted first with oscillator frequencies of 40 and 2000 cycles, then 60 and 2000, and lastly 100 and 2000 cycles, the output of the high frequency oscillator to be 12 db. down on that of the low frequency oscillator. Mr. Foster pointed out a listener can tolerate 6 per cent. intermodulation.

Mr. W. L. Harrison thanked the speaker for his interesting address, and a hearty vote of thanks was accorded to the speaker. The serving of supper concluded yet another successful meeting.

Christchurch Branch

At the monthly meeting of the Christchurch Branch of the Institute, members heard a lecture by Dr. C. Ellyett, who spoke on the subject, "The New Science of Radioastronomy."

Dr. Ellyett has just returned from three years spent as I.C.I. Research Fellow of the University of Manchester, where he was engaged on the investigation of meteors by radar methods at the new geophysics station maintained by the university.

The speaker first described early attempts to track meteors by visual means, but pointed out that these observations could only be made at night when atmospheric conditions permitted.

Jodrell Bank Research Station, where Dr. Ellyett was engaged, first came into existence in 1945, using wartime radar equipment. A visual "range" C.R.T. display was used at first, which made observations tiring and difficult. Additional automatic equipment was developed which discriminated between true meteor echoes and interference, and photographed the display tube whenever a true echo was presented. The meteor echoes were fed in addition to a second C.R.T. with a slow time sweep of one-tenth of a second. This display thus revealed the difference in amplitude of successive echoes from the same meteor, and enabled information on winds at 10 km. heights to be obtained from the bending and distortion of the completed trail.

A peculiarity of meteor responses is that an echo is only obtained at first over a short range of its path, where it is perpendicular to the line of shoot of the transmitter beam. For height determination, the "split" display, first used in C.H.L. radar for accurate bearing determination was employed. For this purpose a single transmitter is used to excite alternately two aerials located at different heights, and consequently with different radiation lobes. These alternate responses were caused to appear slightly displaced horizontally on the time trace, and from their relative instantaneous amplitudes the height could be estimated.

Such detailed studies of meteor trails were leading to considerable new knowledge of the density of other physical properties of the upper atmosphere.

Also located at the research station is the world's largest parabolic antenna. This is 170 feet in diameter, with a central mast 120 feet high, and is coupled to a receiver for the study of "star noise." A point of interest was that at certain points in the sky, typical "star noise"

(Concluded on Page 48.)

ATE

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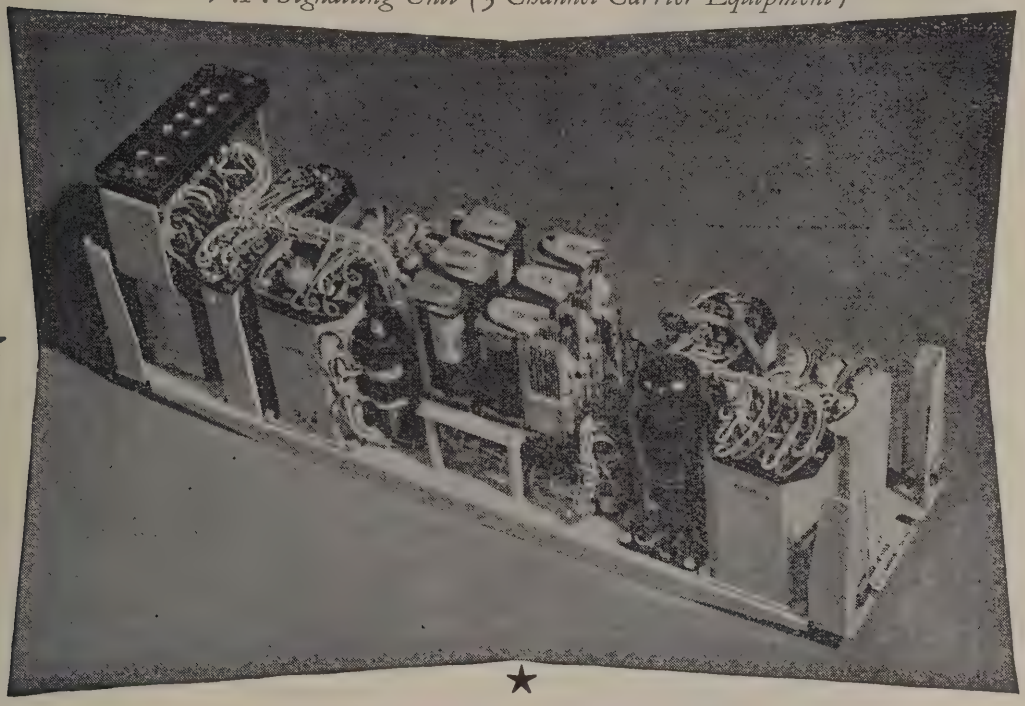

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OUR GOSSIP COLUMN

Mr. H. V. Slade

Mr. H. V. Slade, Managing Director of the Garrard Engineering and Manufacturing Co., Swindon, England, has been a welcome visitor to this country over the past few weeks. In company with Mr. Paykel, of Fisher and Paykel, Ltd., Auckland, he carried out a 2,500-mile tour of New Zealand to meet people who have trade connections with his company. In between, Mr. Slade managed to do a little fishing—trout in Southland and Taupo, and big game fishing whilst he was in the North. We understand that Mr. Slade is quite happy with all results! Mr. Slade's company make the Garrard automatic record changers, radiogram units, electric gramophone motors, spring gramophone motors and pick-ups. Some idea of the extent of Garrard operations may be gained from the fact that they have 1600 employees and that they produce the automatic record changers at the rate of one every thirty seconds, off the final testing line. During the war they made light technical units for radar equipment, bomb fuses, and small electric motors for mines, etc. Garrard are now exporting to over 50 countries, including trade with the U.S.A.

Mr. Slade who was accompanied by Mrs. Slade, departed early in April to continue a world tour which takes in South Africa, Australia, and the United States.

* * *

Mr. J. R. Robertson.—Now the active proprietor of his own business, "Robbie" looks forward to meeting old friends at the Sphinx Manufacturing Co. Ltd., Auckland. Numerous lines handled by this company are of interest to the radio trade.

* * *

Mr. J. D. Bull.—The new General Manager of N.Z. Industries Ltd., is young Mr. Johnny Bull who is kept busy these days with frequent trips to Wellington on company business. Plans for expansion of this company appear to be well forward.

* * *

Speaking of expansions, have you heard of Wingates latest move? Their wholesale radio business under Harold Barr has grown too big for itself! Result, the radio and electrical section now occupies its own quarters away from the parent shop. You will find Harold Barr at his department now in Little Queen Street with a floor space that extends right back to Albert Street.

EMPIRE GAMES CARNIVAL

"You can't realize what you are missing until you hear a modern radio receiver." This was the advice behind Radio (1936) Limited's advertisement at the recent Trades Exhibition organized by the Auckland Public Relations Office as part of the very successful Empire Games Carnival.

Given the opportunity of representing the radio trade at the show, Radio (1936) Limited rose to the occasion splendidly. One hundred and thirty-six thousand people passed through the exhibition halls where the radio pavilion was amongst the modern and eye-catching displays. Murals, show-cards, lay-out, and demonstrations contributed to the success of the underlying theme. Power was supplied with these modern radios. Working models of "Ultimate" receivers from as far back as 1929 were demonstrated against the latest productions from the company's comprehensive range, emphasizing the tremendous advances made in musical reproduction. Pastel shades of blue with an off-white background gave unusual "pulling power" to the exhibit.

Tremendous interest was centred upon the piano acoustic Challen radiogram consolette, and the company's new AC/battery "Gypsy" portable receiver.

The company was honoured by His Excellency the Governor-General who paid a visit to the pavilion and expressed his interest in New Zealand-made receivers and the high quality attained.

Hundreds of visitors heard and examined the 1929 receiver used by the company's designing engineer (Mr. R. J. Orbell) on the first Byrd Antarctic trip, and were shown the development made in radio over the years leading to the near perfection of the enchanting 11-valve all-wave lowboy radio gramophone model.

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Servicemen and Assemblers

Indispensable for handling Miniature Valves

VALVE EXTRACTING TOOL
Avoids damage to valves, saves burns and cut fingers. Simple, efficient, foolproof, one-hand operation only, automatic action.

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Ensures perfect alignment of miniature glass-base valve-pins.

SOLDERING JIG
For accurate alignment of Miniature Valve Holder Contacts when wiring. Pins of hardened carbon Steel.

All the above are available for the following valve types: B7G (Miniature Glass Base), B8A, B8G, B9A (metal ferrule at bases).
Above listed "*Spearette*" Tools can be obtained at very small cost. Don't be without these essentially modern time and cost-savers.

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TRADE WINDS

Fifty Years.

Westinghouse Electric Co. (U.S.A.) in their January, 1950, issue of *Westinghouse Engineer,* looks at technical progress of the preceding half-century and in a forecast of the future sees no levelling off in engineering progress, but rather envisages "still larger worlds to conquer," and that by the end of the year 2000, those who review the record of the twentieth century will write, "The last half century was richer than the first."

* * *

A Record of Service

International General Electric Co. Inc. (U.S.A.) has recently celebrated its thirtieth year of existence, and in a voluminous brochure entitled "A Record of Service" reviews its activities in the foreign and domestic field. Today I.G.E. has representation in 70 countries and wherever operations are conducted the company works closely with Governments and industry, and continues to strive for, and believe in mutually profitable relationships between themselves and all other nations. The parent company of I.G.E., the General Electric Co. (U.S.A.), dates back over 51 years.

* * *

Cory Wright and Salmon Ltd. announce that they are now New Zealand representatives for four more well-known British firms: Frederick Smith and Co., wire manufacturers of Halifax; Aluminium Wire and Cable Co. Ltd., of Swansea; The Mint Birmingham Ltd.; and R. J. H. Tool and Equipment Co. Ltd., Heckmondwicke.

* * *

We have been asked by the company concerned to make the following announcement: "Green and Cooper, Ltd., of Wellington announce that Mr. Walter S. Green has disposed of his entire interests in Green and Cooper, Ltd., to Mr. A. M. Cooper, and in future the Company will be entirely under his management.

"Green and Cooper Ltd., will continue business with all existing overseas and New Zealand agencies as in the past."

Publications Received:

From Standard Telephones and Cables Ltd., Leaflet F/SRL 9, "Sen-Ter-Cel" Miniaturement H.T. Rectifiers.

Metropolitan Vickers Electrical Co. Ltd., Wellington, "Seascan," a special publication on marine navigational radar. Descriptive leaflets covering electronic control equipment for industry; various bulletins covering cathode valves, photo-electric relays, 100 k.v. electronic microscope, miniature cathode ray oscilloscope, universal audio amplifier, etc.

Green and Cooper, leaflets on "Spearette" valve extracting tools, etc.

ARGENTINE ORDERS MARCONI TRANSMITTERS

The Argentine Government, who are planning to have the most powerful broadcasting system in South America, have placed an order with Marconi's Wireless Telegraph Co., Ltd., for two 100 kW medium wave, air-cooled transmitters. This contract was obtained by the Marconi Company in the face of keen American and Dutch competition; and a Marconi technical expert was specially flown to Buenos Aires last summer to take part in the negotiations.

These transmitters are of the latest air-cooled type similar to equipment which is being supplied by the Marconi Company to the B.B.C.

A Marconi high constancy crystal drive is also being supplied by the Marconi Company for use with these new transmitters. The crystal drive will ensure the highest order of accuracy. It has a day to day frequency stability of one cycle in one hundred million (1 in 10^8).

Both these 100 kW transmitters are to be installed at Gral Pacheco, about 15 miles from Buenos Aires, and arrangements are being made so that the two transmitters can be worked in parallel to give a total output of 200 kW when required. Gral Pacheco will thus be the most powerful broadcasting station in all South America.

Prior to the placing of this contract the Marconi Company had also received an order from the Argentine Government for two 20 kW transmitters, for local broadcasting, one of which will also be installed at Gral Pacheco. The other is destined for Santa Rosa.

* * *

AUCKLAND PROVINCIAL RADIO TRADERS' ASSOCIATION

Plenty of good work is being done by this Association. New members admitted during March were Crawford Radio and Electrical Service and Vickery's Radio Service. The Police Department are co-operating with the association to track down stolen radios and lists of radios stolen from their premises are urgently sought from all radio dealers in Auckland.

On the lighter side of things the Association plans a radio ball and a trade exhibition is to be held in conjunction therewith. Future general meetings of the Association are to be held during the evenings to suit the convenience of the members.

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VALVE VOLTOHMMETER TF887

Ranges and Facilities:

A.C. Volts: 0–125v. in 3 ranges, 20 c/s. to 300 mc/s., or up to 500v. with multiplier.

D.C. Volts: 0–250v. in 4 ranges, or up to 1000v. with multiplier and up to 5000v. with high-voltage probe.

Resistance: Up to 2 megohms in 3 ranges.

AUDIO TESTER TF894

Ranges and Facilities:

Frequency: 50 c/s. to 12 kc/s.

Output: Continuously variable up to 300 mW. into 600 or 5000 ohms (13.4v. and 38.8v.).

Attenuator: 0–50 db.; 600 ohms

Voltmeter: 0–80v. in 4 ranges, 50 c/s. to 12 kc/s.

Power Supply: 200–250v., 40–100 c/s.

VALVE MILLIVOLTMETER TF899

Ranges and Facilities:

Voltage: 0–150, 0–500, and 0–2000 mV in the range 50 c/s. to 100 mc/s.

Input Conditions: Resistance greater than 1 megohm at 1 mc/s. Capacitance approximately 7 mmf.

Power Supply: 200–250v., 40–100 c/s.

Complete technical information available on request from:

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RADIO CONTROL RECEIVER

(Continued from Page 8.)

THE CIRCUIT IN DETAIL

Looking at the detector circuit, the lower tuned circuit is the R.F. one. The tuning condenser is a Philips trimmer, and the coil is a home-made one, of a few turns only, wound on a piece of ½ in. bakelized fibre former. The upper tuned circuit, with the 500 $\mu\mu$f. mica tuning condenser, is made from a commercial 100 kc/sec. B.F.O. coil, by a method to be described. The R.F. oscillator will be recognized as the ultra-audion circuit. The diagram shows the tap off centre, but is actually at the centre of the coil. Now if the R.F. choke connected to the grid of the DL72 is imagined removed, and if the lead from the centre-tap on the R.F. coil were taken to the H.T. plus, the circuit is seen to be nothing more than the Ultra-audion circuit. So far, so good.

Now, the quench oscillator coil is also a tapped one, and its circuit as an oscillator is essentially identical to that of the R.F. oscillator. The R.F. choke from the grid to the grid end of the quench coil is designed to act only at R.F., and to be virtually a short circuit at the quench frequency. Similarly, the R.F. coil can be considered to be a short circuit at quench frequency, so that in connecting the plate end of the quench coil to the plate of the valve, the R.F. coil might just as well be absent. In this way, the two circuits are attached to the tube so that both oscillations are able to take place simultaneously. The tap on the quench circuit is bypassed to earth by a 500 $\mu\mu$f. condenser, without which the super-regeneration will not take place. The detector is then connected to H.T. through a 20k. resistor, which forms the load for audio frequencies, *i.e.*, the noise that is to be amplified. Next we have the coupling circuit to the grid of the DF70. First there is the 0.002 μf. blocking condenser, followed by a filter, comprising a 25k. resistor and a 0.001 μf. condenser. These two components form a low-pass filter, and remove a good deal of the 50 kc/sec. quench voltage, while having negligible effect on the noise voltage output. The DF70, which is the voltage amplifier pentode of the sub-miniature series, is connected as a straight forward audio amplifier, and has a voltage gain of approximately 24 times. Its plate circuit is coupled to a blocking condenser, and a further quench filter circuit, having the same values as the one in the grid circuit, to the grid of the third tube, which acts as a further audio amplifier, and at the same time as the relay tube. The lower end of the 25k. grid leak completes the grid return circuit through the 100k. filter resistor for the crystal diode rectifier. The latter, with its 2 meg. load resistor, is fed from the plate of the relay tube, by the 0.05 μf. coupling condenser. At the high end of the load resistor is the usual audio filter found in conventional A.V.C. rectifier circuits, and this consists of the 100k. resistor together with the second 0.05 μf. condenser. From this general circuit description, it can be seen that the whole set is very similar in circuit to the one described by Mr. Wright, and that only in details is it different.

The greatest difference is the use of a separate quench coil instead of a true self-quenched detector. Next, there is the elimination of the audio choke from the plate circuit of the detector, this being replaced by a resistor. It was found that the performance of the set with the resistor was actually superior, in that the low-frequency noise is able to get to the audio amplifier more readily than when a low-inductance choke is used. A choke with a high enough inductance to have a similar low-frequency response would be too bulky and heavy to use where lightness is a major consideration. Another difference that readers will note is the different connection of the relay. The plate of the relay tube has a 50k. load resistor in series with it instead of using the relay winding as a plate choke. The reason for this is that the ultra-sensitive moving coil relay has only a very low impedance to alternating current—not high enough to allow it to be used in this way. The alternative was to put in an audio choke or a resistor. The resistor was preferred because it helped in another direction, namely in reducing the minimum current passed by the relay tube. It also helps to reduce weight.

THE QUENCH OSCILLATOR COIL

One of the reasons for using the separate quench coil is that it enables us to know exactly what the quench frequency is, whereas the self-quenching circuit may be squegging at any frequency within a wide range. It is much easier to filter out the quench voltage from the noise if the quench frequency is high, and this is the reason why a high quench frequency—about 40 to 50 kc/sec.—has been employed. Unfortunately, oscillator coils suitable for this frequency are not available, but oscillator coils for 100 kc/sec. are. The commercial units are intended as B.F.O. coils for receivers which have a 100 kc/sec. I.F., and are tuned with an iron-dust slug. To make the quench coil from one of these, it is removed from its can, the tuning slug is removed, and a condenser of 500 $\mu\mu$f. is connected across it instead of the small condenser put there by the maker. The winding is in two parts, closely coupled together, and wired in series. This is just a convenient method of tapping the winding, for the coil is meant to be used with an indirectly-heated valve as a Hartley oscillator, with the

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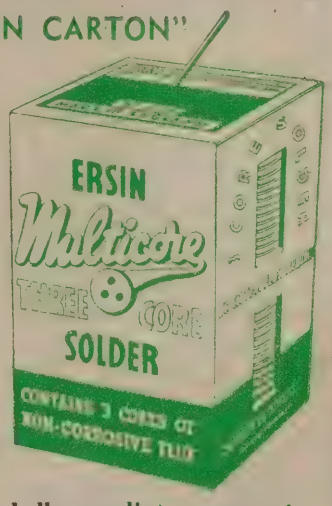

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cathode connected to the tap, and the coil from grid to earth. Here, we use the tap to feed the H.T through, and we connect the end of the coil which has a black spot on the lug to the 0.0001 μf. grid condenser, and the end with the green spot goes to the centre-tap on the R.F. coil. The tap has a yellow spot, and goes to the 20k. plate load resistor.

The purpose of the 180k. resistor shunted across the quench oscillator coil is to reduce its Q and therefore the oscillator output at quench frequency, to the correct value to give proper super-regenerative action.

There is nothing abstruse about the DF70 audio amplifier circuit, so we will pass on to the DL71 amplifier-tube-cum-relay-tube. Here, the only thing that might need a little explanation is the polarity marked on the crystal diode. These things are marked in the opposite way from what might be expected. The end marked *negative* corresponds to the plate of a diode valve. It can thus be seen that the rectified voytage applied to the grid of the DL71 is negative, in accordance with the marking on the crystal. The connection of the relay may cause some comment, however. We have already explained why a load resistor is necessary in the plate circuit of the last valve, but not the somewhat peculiar arrangement of the relay windings. The relays referred to have two separate windings, which may be connected in a number of ways. If they are wired in series aiding, a coil current of 75 μamps is enough to close the relay. If one coil only is used, 150 μamps is needed to close the relay, and the other coil can be used for other purposes. This time, we have short-circuited the unused coil, because this increases the damping on the armature, in just the same way as a shunt or a short-circuit on the coil of a moving coil meter effectively damps out the movement of the needle. With the unused coil shorted, there is less likelihood of bumps or jerks allowing the coil to move far enough to close the contacts unintentionally. No trouble was encountered due to this cause.

CONSTRUCTION

It is rather difficult to describe the construction of such a small unit as this at all adequately, but we have done our best by means of photographs, helped out by a wiring diagram. The piece of insulating board that the set is built on measures 3 in. x 1¾ in. In the upper left corner of the top view, can be seen a plan view of the R.F. oscillator coil, on its former ½ in. in diameter. Immediately below it is the Philips trimmer. In the lower right corner is the relay, and to the left is the quench coil, whose connecting lugs can be seen quite clearly. In the underneath view, the large winding of the quench coil can be seen clearly, with the small postage-stamp

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500 $\mu\mu$f. condenser hiding the end of the former which was sawn off immediately below the coil. The leads from the 500 $\mu\mu$f. condenser go up through the coil former and connect to the appropriate lugs. Below the Philips trimmer in the top view, can be seen an end view of a small paper condenser. This is the 0.002 blocking condenser, and its lead can be seen attached to the yellow lug on the quench coil. The square condenser which is also connected to this point is the 0.0005 μf. condenser to earth from the yellow lug. To the right of this can be seen the R.F. choke which is wound with fine wire on a ¼ watt resistor. The fourth lug on the quench coil former is unused, and so it is made a tie point for the R.F. choke and the 0.0001 μf. condenser, the other end of which attaches to the black lug on the coil former.

All that has been said can be followed on the wiring diagram. On this the points marked with numbers represent solder lugs, riveted on to the insulating board. These lugs are the kind that end in a small tubular rivet, and are easily put on through a hole ⅛ in. in diameter, or a little smaller, and fixed in place by spreading the end with a centre punch and a light hammer. There are two rows of these, as can be seen from the wiring diagram. They are about ⅛ in. apart, or a little more, and the rows are half an inch apart. Three other lugs are inserted, two for the aerial (Nos. 18 and 19) and another below No. 16, called No. 17. It will be seen that some of the components in the diagram are drawn in full lines, together with their wiring, while others, and some of the wiring, is dotted. The parts and wires that are fully drawn are above the board, while the dotted ones are underneath. Where a dot is shown, with no number attached, it merely represents a hole in the board, through which one of the wires is taken. A case in point is the 0.002 μf. condenser connected from the tap on the quench coil to the first

(Continued on Page 47.)

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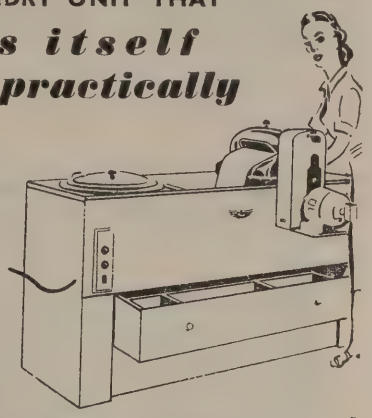

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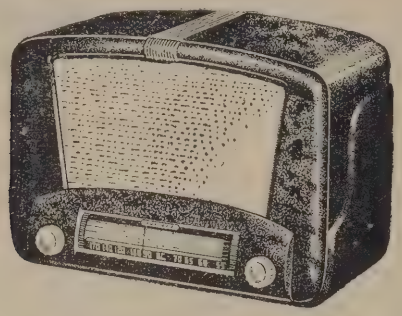

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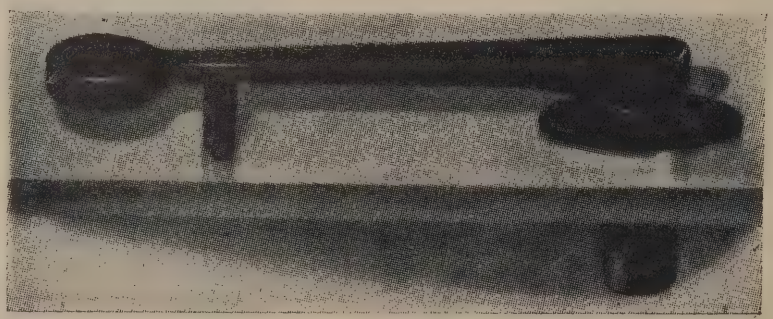

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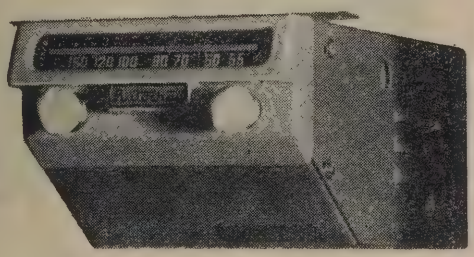

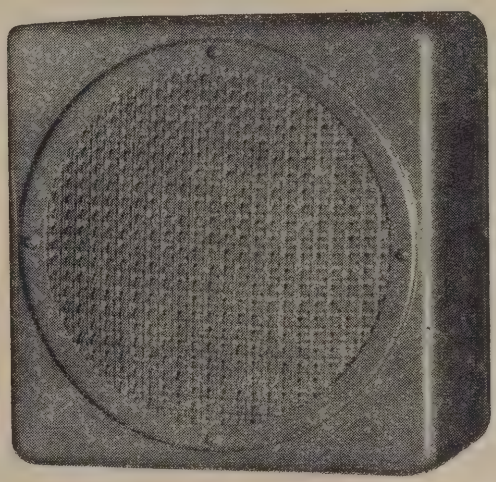

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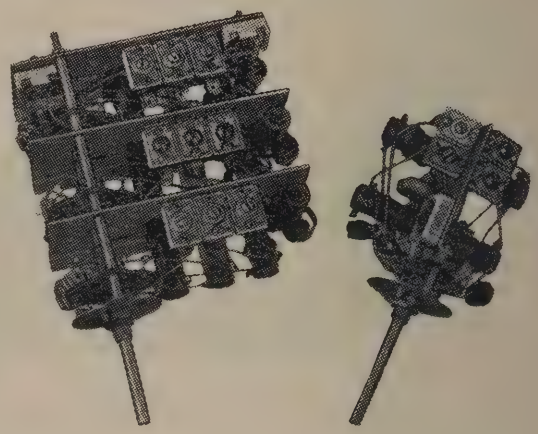

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(Continued from Page 26.)

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The "Auratone" pocket radio receiver is a product of Auratone Laboratories Ltd., of 46 Gray's Inn Road, London, England, W.C.1.

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RADIO CONTROL RECEIVER

(Continued from Page 43.)

filter, and thence to the grid of the DF70. This condenser is the one referred to above, which is stood on end. One of its leads is connected to the coil lug, and the other is taken through the hole, and soldered to the underneath of lug No. 10. The square blobs represent the lugs ond the quench coil former. This diagram, together with the table of connections should enable readers to duplicate the lay-out exactly, and there is no point in elaborating further on it.

One thing should perhaps be mentioned. It is the method of mounting the quench coil. To do this, a hole is bored in the base-board, large enough for the small winding to just pass through. The coil is then inserted from the back, and is held in place by means of melting some condenser or coil wax round it. Similarly, the Philips trimmer is mounted by making one hole for the centre pin, and another for the side lug. The trimmer is then inserted in these holes, and the side lug is bent over, fixing it in place. The valves, of course, have no bases, and are simply wired in place after spaghetti has been placed on the leads to prevent them touching anything they should not. The 45 $\mu\mu$f. in the R.F. oscillator circuit is made from three 15 $\mu\mu$f. midget silvered ceramic condensers in parallel. These should definitely be used in place of a single 50 $\mu\mu$f. mica condenser, on account of their superior characteristics.

We had hoped to complete the description of this receiver in this issue, but owing to its novelty in design and construction, we have found it impossible to include the necessary information on setting up the receiver once it has been built. This will have to wait over, and will be included in the June issue of this journal.

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ACTUATOR MECHANISMS

(Continued from Page 13.)

interested in the subject of radio control of models and who want to read about the latest developments in the field, could do no worse than purchase some of the English model aircraft magazines that are obtainable here, for the subject has become so popular among modellers there that the two best known magazines devoted to model aircraft activities now run a monthly section on radio control matters. Not much gen will be found on the electrical side, however, because in England and America most of those who are interested in the work are not radio men, and use commercial radio equipment. However, from time to time, in our own pages we hope to keep readers up to date with the electrical side, as the present issue shows. For one thing, we have no hesitation in saying that Mr. Wright, who has constituted himself our guide, philosopher, and friend in radio control matters, is as expert in the field as anyone else in the world, both in the model side and the radio aspect. In fact, his receivers, we are convinced, are far more reliable than the commercial ones marketed in England, to judge by some of our own reading lately.

Henceforward, we will confine our descriptions to radio and electrical matters only, as befits a radio magazine, but it is hoped that the present article on things mechanical will enable many interested radio people to get started on what is undoubtedly one of the most fascinating aspects of radio work.

●

PORTABLE TRANSMITTER

(Continued from Page 23.)

preliminary adjustments have been made in this way, the instruments can be put away, and only pulled out again to test the condition of the batteries!

TROUBLE DUE TO THE KEY LEAD

With the original transmitter, one very troublesome fault occurred, and it was not until several things had been tried that the correct solution was hit upon. When a plug with very short leads was inserted in the keying jack, for test purposes, all was well, and the transmitter delivered full power quite happily. However, when any length of key lead greater than a few inches was substituted, the aerial current unaccountably dropped to about third of what it should have been, and nothing that could be done in the way of trimming the length of the lead had any effect on the performance. The final solution was the insertion in the leads to the key jack of a pair of R.F. chokes. By-passing the jack terminals to the case had no effect whatever, but the moment the chokes were inserted, the aerial current was back to normal, and the performance was identical with the longest lead, or with no lead at all. In the field, this would be important, because it is very desirable for the person using the transmitter to be well away from it, mostly so that if he is watching the sky, he will not fall over it. It is therefore suggested that at least 15 feet of key lead be used, and this will give the operator plenty of freedom of movement.

BATTERY DRAIN

As can be seen from the size of the complete transmitter, including batteries, which are all housed inside the case, there is hardly room for heavy-duty batteries. Since the B drain is over 30 ma., the latter would not be out of order, if it were not for the extremely intermittent nature of their load. The A battery is designed to carry the filament current without trouble, but the miniature B batteries (type 467) that were used are not intended to give anything approaching 30 ma. Since the transmitter is actually on only when a signal is being sent, this does not matter very much at all, and the small batteries will be found to give quite satisfactory life for all practical purposes.

●

ABSTRACT SERVICE

(Continued from Page 28.)

cent. regulation. The units are of the r.f. oscillator type and of simple and safe construction.

—*Electronics* (U.S.A.), February, 1950, p. 98.

A valuable summary is given of electrical aids to navigation and the methods adopted in U.S.A. to ensure scheduled aircraft movements without regard to weather conditions.

—*Electronics*, February, 1950, p. 66.

Nature's high-voltage systems exemplified in electric fishes; a study of the energy sources of these fishes especially the "electric eel" found in the tropical waters of South America which has an astoundingly potent electric generator.

—*Wireless Engineering* (U.S.A.), January 1950, p. 47.

Further information on transistors and the interaction of "holes" and electrons in semi-conductors. Notes are given on industrial applications of transistors, their advantages being ruggedness and indefinite life, and their disadvantages inability to handle more than a fraction of a watt or very high frequencies.

—*Electrical Engineering* (U.S.A.), January, 1950, p. 58.

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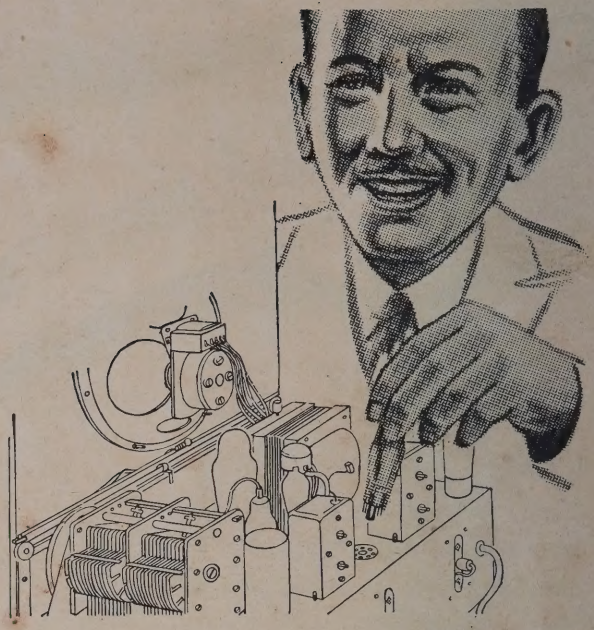

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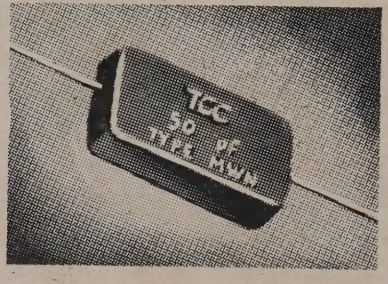

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